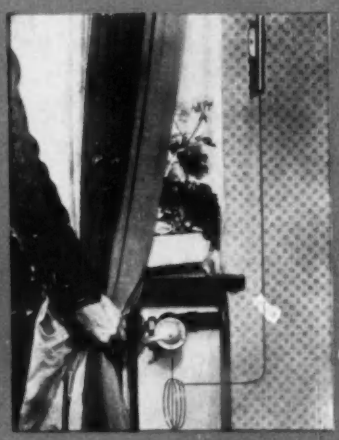
ENGINEERING AND
BOILER HOUSE REVIEW

ESTABLISHED 1899

TWO SHILLINGS & SIXPENCE

VOL. 74 NO. 2 • THE PIONEER STEAM JOURNAL • FEBRUARY, 1959

Normal design with fixed phial.



Special design with capillary tube and loose phial, which can be used where the natural air circulation is checked.

Special design for covered radiators.

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A simple and lasting solution. It is a question of getting the fuel to go as far as possible.

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Danfoss

thermostatic radiator valve

- Great sensitivity
- Economical operation of the plant
- Easy operation
- No stuffing box
- Phial unit can be interchanged without draining of the system
- Will prevent freezing
- Temperature range between 37.4 F. and 77 F.

The Danfoss Thermostatic Radiator Valve is provided with an adjustable temperature scale and is constructed so that each radiator is regulated separately. It can be used for all central heating plants and gives a new feeling of comfort as well as a considerable saving of fuel.

With a Danfoss Thermostatic Radiator Valve you determine the temperature.

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everything under Danfoss control

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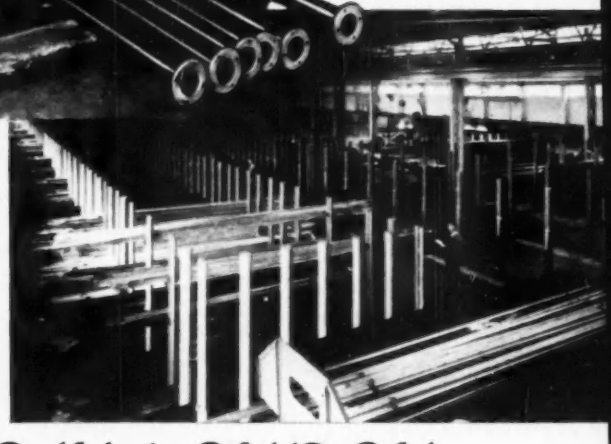

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Stewarts and Lloyds, due to increased demands for their products, have moved from Kennington to a new warehouse and fabricating shop at Bow, London, E.15 where they can offer an even better service to their customers.

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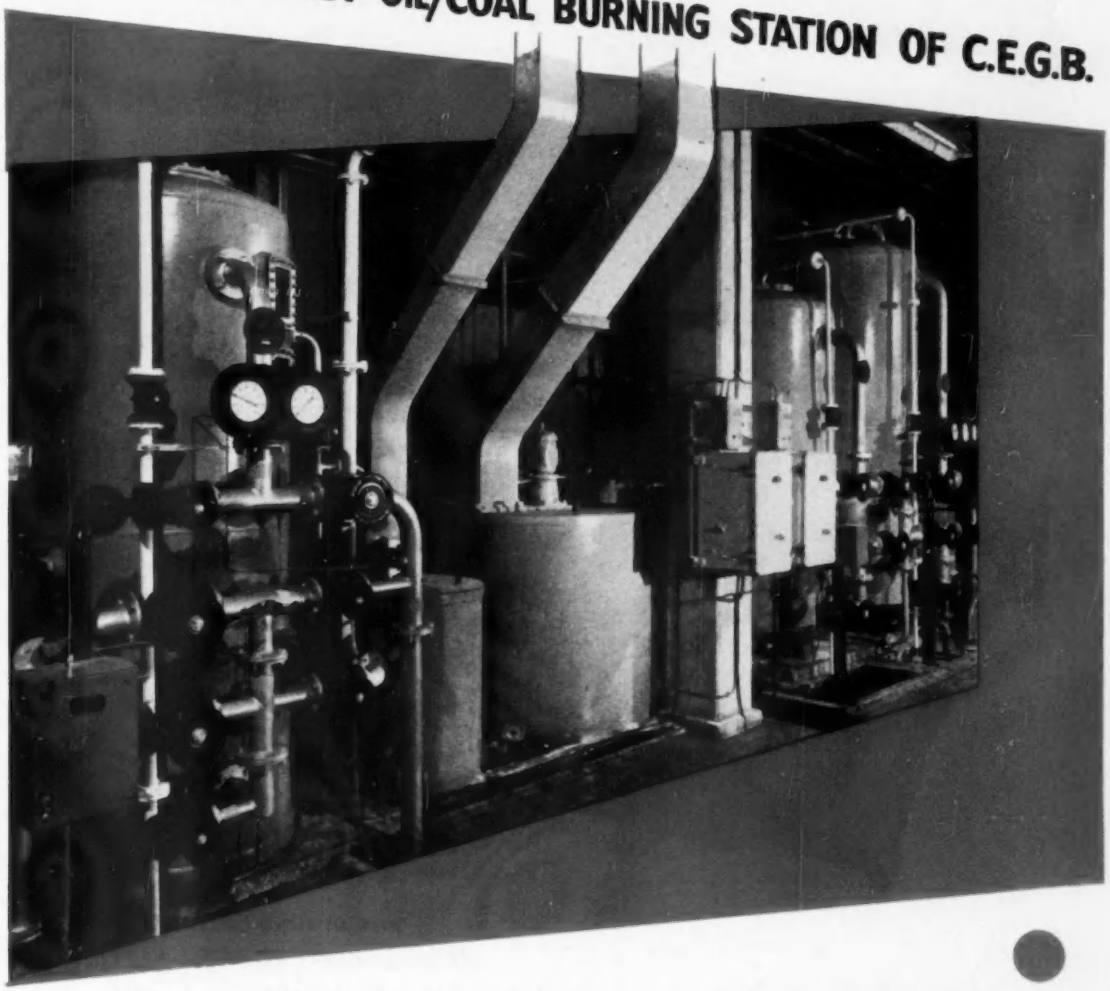

The boilers at C.E.G.B. Marchwood Generating Station operate at 925 lb. per sq. inch, and are provided with "Deminrolit" treated make up feed. There is no split responsibility with a "Deminrolit" Plant because Permutit design and manufacture the Plant, also develop and manufacture their own Ion Exchange Resins. This is exclusive to Permutit.

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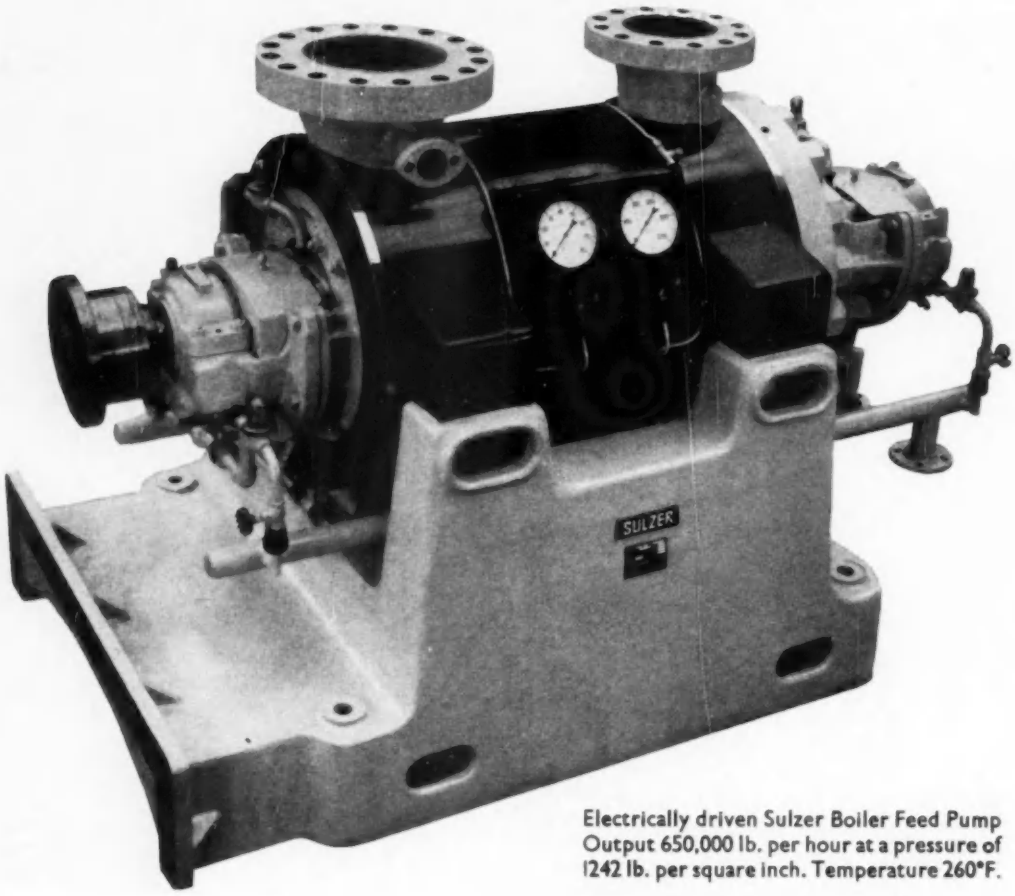
BOILER-FEED PUMPS



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Output 650,000 lb. per hour at a pressure of
1242 lb. per square inch. Temperature 260°F.

one of nine units for
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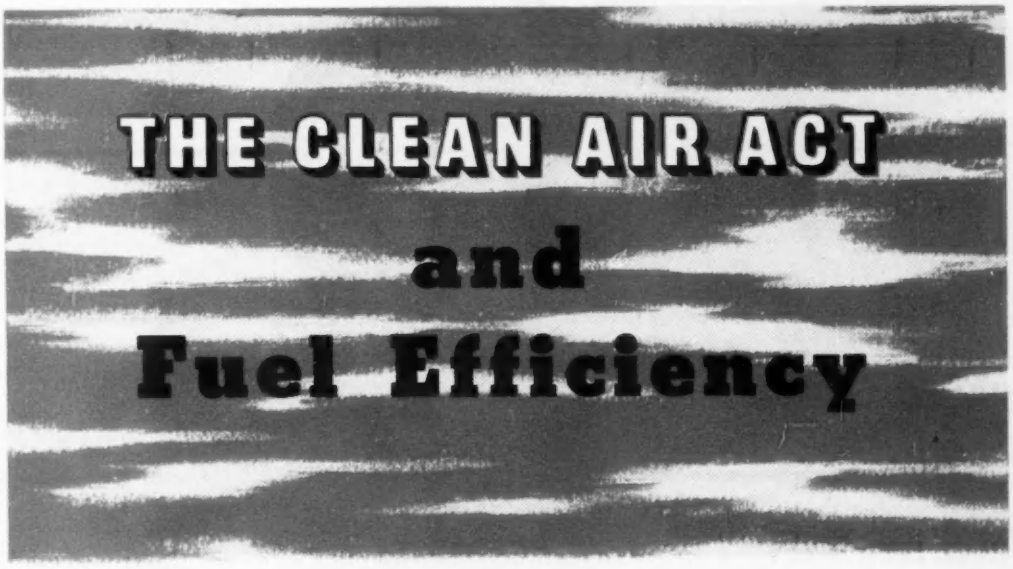

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He would wriggle out of it

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prevents corrosion in steam-raising plant
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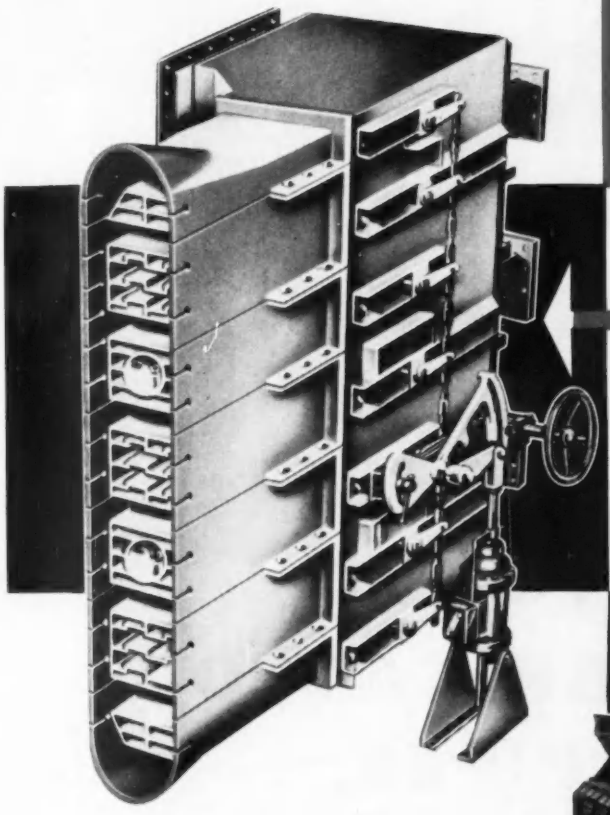
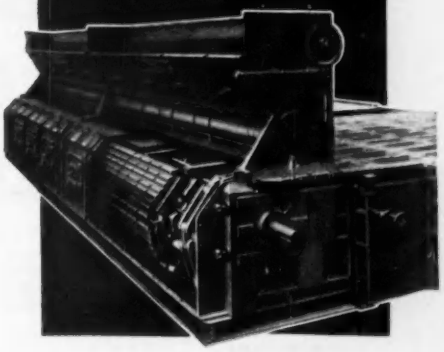


Burner
or
Stoker?



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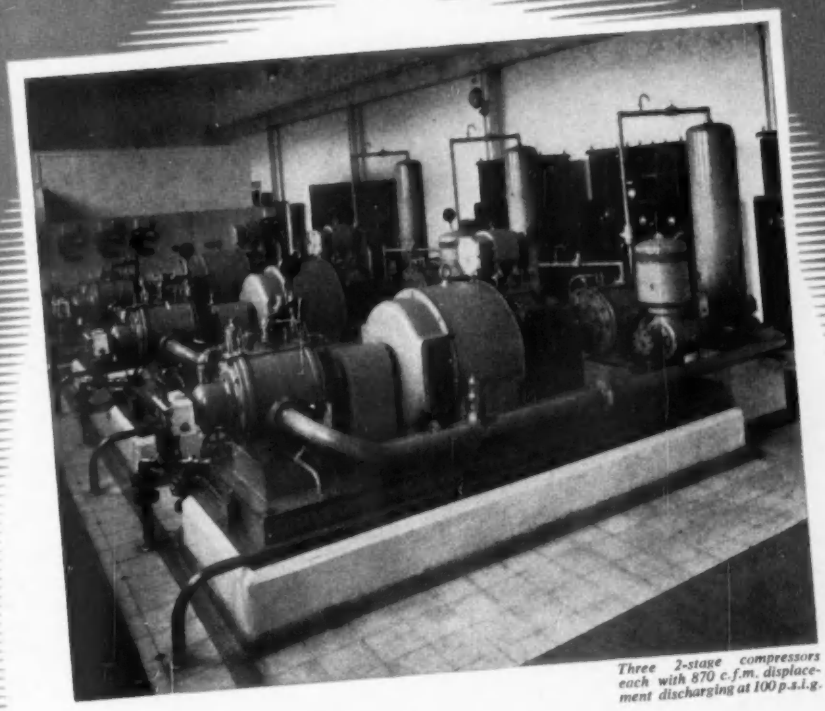

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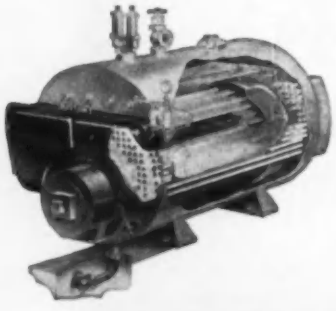

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Consulting Engineers: Brandt and O'Dell, London. *Heating Engineers:* Pearsons (Installations) Ltd., Leeds

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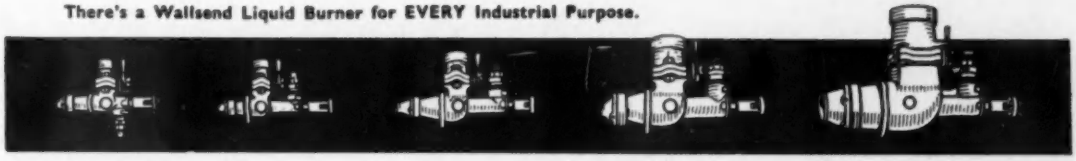

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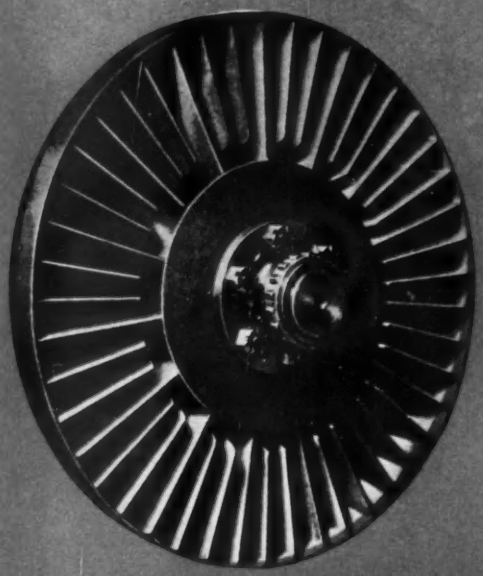

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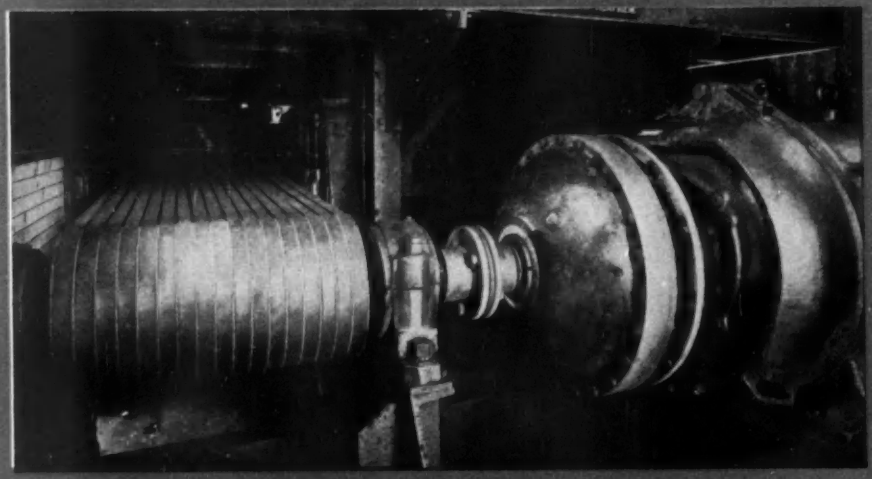

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starting with Zerox*

The first *complete* Power Station to operate at 1,500 p.s.i. and 1050°F. was opened at Drakelow in October 1955. Right from the beginning, Zerox (35% hydrazine) was chosen for the treatment of the boiler feed water. By the end of the first year, Drakelow had proved itself to be the most efficient Power Station of its kind in Great Britain. Since then it has completed a further two years of exemplary service for the East Midlands Division of the Central Electricity Generating Board, maintaining, for this type and design of Station, an unsurpassed standard of performance.

Zerox, an ideal method of removing dissolved oxygen *throughout* the steam/water cycle, is particularly suitable for high-pressure working. Furthermore, Zerox does not increase the dissolved solids and, far from producing acidic substances, actually helps to keep the water alkaline.

The results—less blow-down, purer water, cleaner internal surfaces—explain why Drakelow and numerous other Power Stations use Zerox

to ensure maximum efficiency

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For more FACTS about ZEROX, its advantages and application, write to WHIFFENS, sole manufacturers, for Leaflet H/H/2—or for the fully bound book of the International Conference on Hydrazine and Water Treatment held in May 1957. Price one guinea, plus 2s. 6d. postage and packing (in the U.K.)

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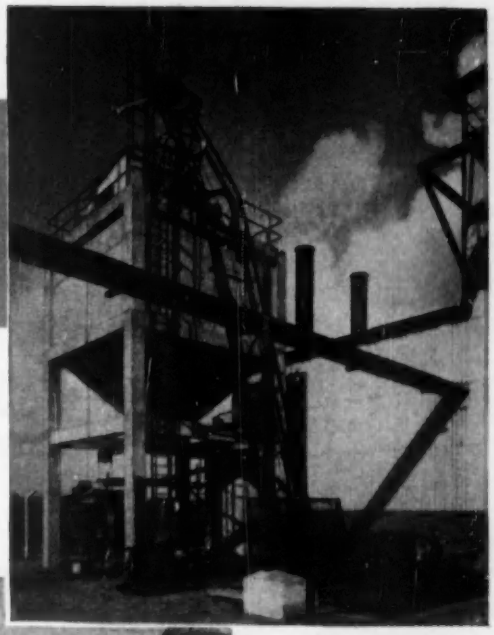
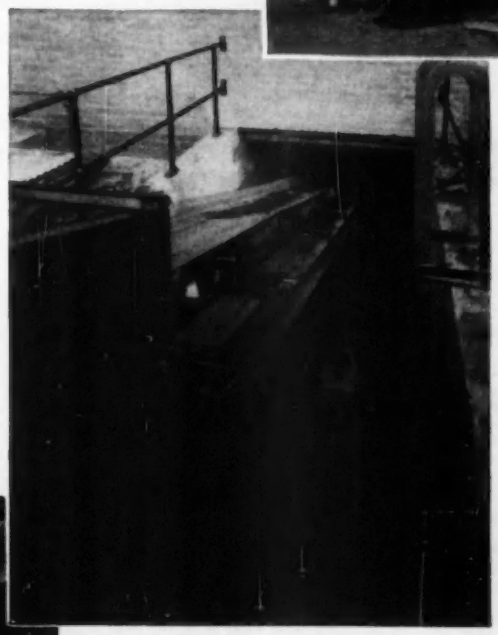
W37

JOHN THOMPSON
Submerged Ash Conveyors



In the John Thompson Ash Conveyor the ash from the boiler furnaces falls through water to a submerged belt conveyor. The ash is immediately quenched, and no dust can escape. The conveyor works at low speeds and requires very little power to drive it. Wear and upkeep are practically nil.



Ash handling from the discharge end of the conveyor to the storage hopper

The discharge end of the submerged conveyor belt emerging from the trough.

The trough with submerged belt, showing the ash chutes from the boilers.

JOHN THOMPSON CONVEYOR COMPANY
JOHN THOMPSON GROUP

JOHN THOMPSON CONVEYOR COMPANY
WOLVERHAMPTON

Have you thought of designing in REFRACTORY CONCRETES?

The idea of "concrete" furnace construction may appear revolutionary, but it has already gained wide acceptance because concrete construction techniques allow the designer and builder to:

THINK IN TERMS OF Monolithic walls, roofs, hearths, etc., NOT brick by brick construction with its joint and other complications.

THINK IN TERMS OF High strengths before, during and after firing.

THINK IN TERMS OF Fast construction, smooth walls, easily constructed suspended roofs—all possible by concrete casting.

THINK IN TERMS OF Composite refractory and insulating structures cast in one piece—Refractory Concretes of varying refractoriness and thermal conductivity are easily made.

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- **Flexibility of design**
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There is a place for Refractory Concrete in every industry. Practically any shape or size of unit is possible by casting.

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up to 1350°C **CASTABLE REFRACTORY CONCRETES** up to 1800°C

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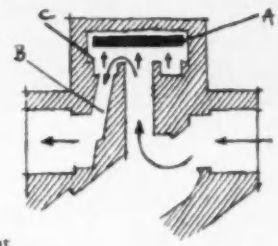
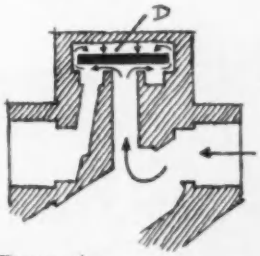
AP/33

The Spirax 'TD' Trap

— how it works

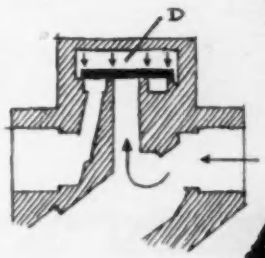


Disc A is raised from seat by incoming pressure, allowing instant discharge of air and condensate through outlet B.



High velocity of following steam creates a low pressure area under disc and builds up pressure in chamber D.

Steam pressure in chamber D exceeds combined force of the incoming steam and the low pressure area. Acting on full top area of the disc, it forces it down and closes the inlet. On no load the valve is thus closed tight.



and how it works!

The Spirax ½ inch 'TD' is all stainless steel with only one moving part. It works in any position, up to 550° F. and without adjustment from 10-350 psi. It has remarkable discharge capacities and is unaffected by superheat, waterhammer, vibration, corrosive condensate and freezing. Full details of this remarkable steam trap in return for the completed request slip below.

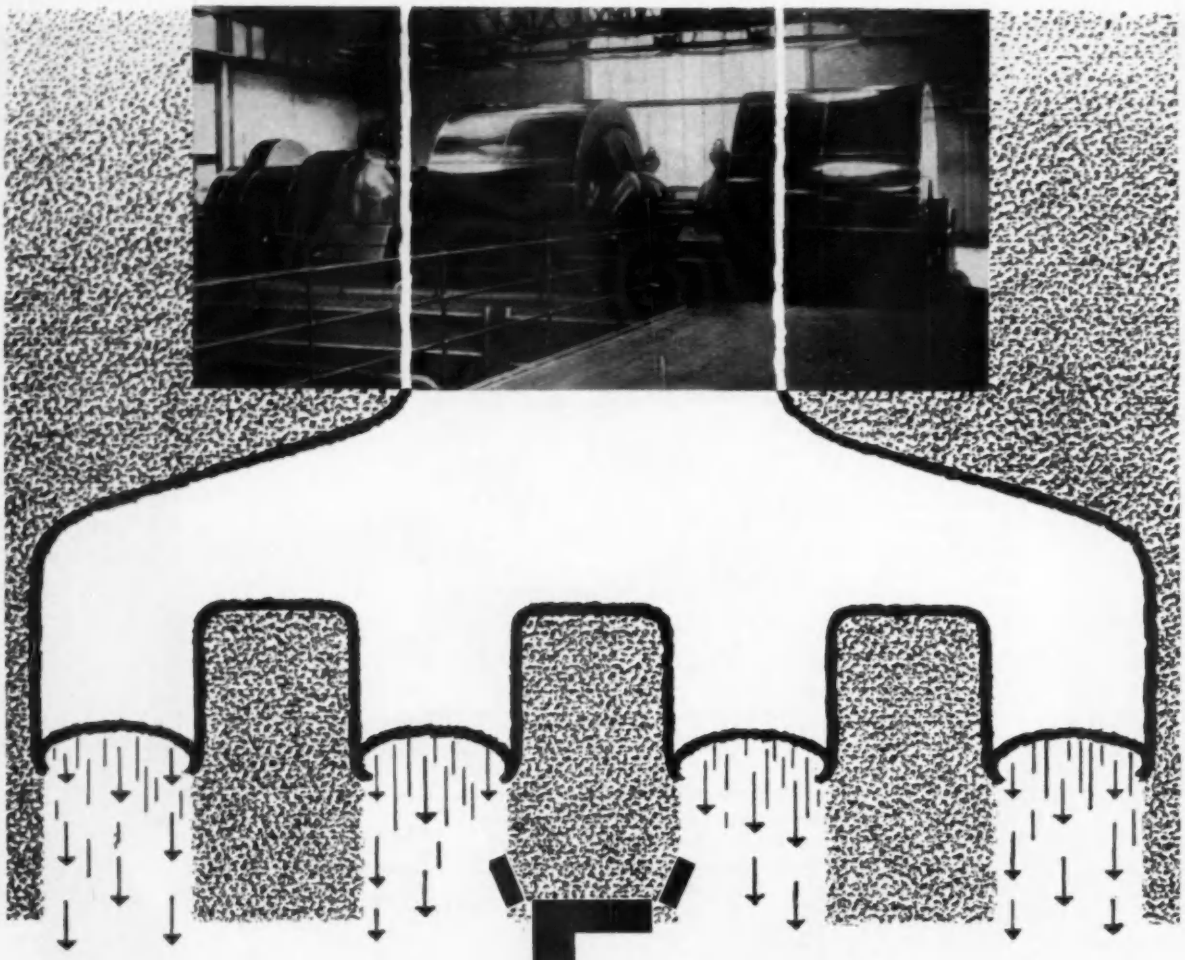
Spirax-Sarco Ltd, Cheltenham, Glos.

Please post full details of the new Spirax Thermodynamic Trap.

NAME

ADDRESS

EB259



GIANT 'E' BLOWS

The world's largest turbo-blower was built and installed by Parsons at the Scunthorpe Works of the Appleby Frodingham Steel Company Branch of the United Steel Companies Limited.

Known as the 'E' Blower, it is designed to supplement the output of the four smaller turbo-blowers, also built and installed by Parsons, or to act as a separate unit blowing air direct to any one, or two, of the four blast furnaces at this modern iron works.

PARSONS

TURBO-BLOWERS

'E' Blower is capable of delivering 160,000 cubic feet of free air per minute at a pressure of 35 lb. p.s.i.

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Wherever there is Nuclear Progress, there are

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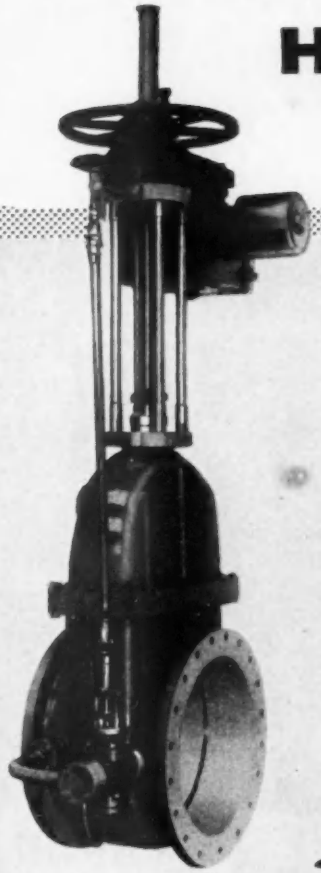

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We are always pleased to explain the benefits and economies effected by the Copes System of Feed Water Control, and our Engineers are ready to give advice and guidance free of all obligation. Please write to us. Literature is also available on request.

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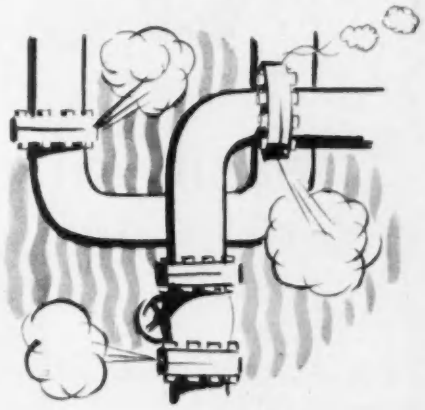
There are lots
of ways of
wasting fuel—
but one good way
of saving it
is to instal a



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E. GREEN & SON LIMITED · WAKEFIELD

Makers of economisers for more than one hundred years

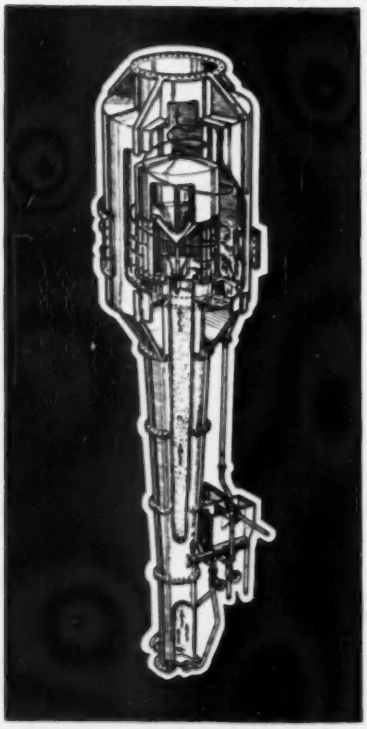
Dust Danger

easily arrested at low cost

The Government's Clean Air Bill has now put dust into its correct perspective—it is no longer just a nuisance or just a problem—it is a DANGER to health and equipment, and it must be removed.

The problem of installing new or replacing old dust recovery equipment is now facing many industrial managements. New plant can be very costly especially if the scheme is not approached properly from the outset.

Thermix Industries Ltd. are pleased to make available their many years' experience in selecting the most economical and technically suitable system of dust control and recovery for each duty from their extensive range of equipment.



We have recently joined the Dunford & Elliott Group and the immediate benefits to clients are highly competitive prices, Laboratory and Test Plant Facilities and first-class After-Sales Service.

The THERMIX range of products includes:

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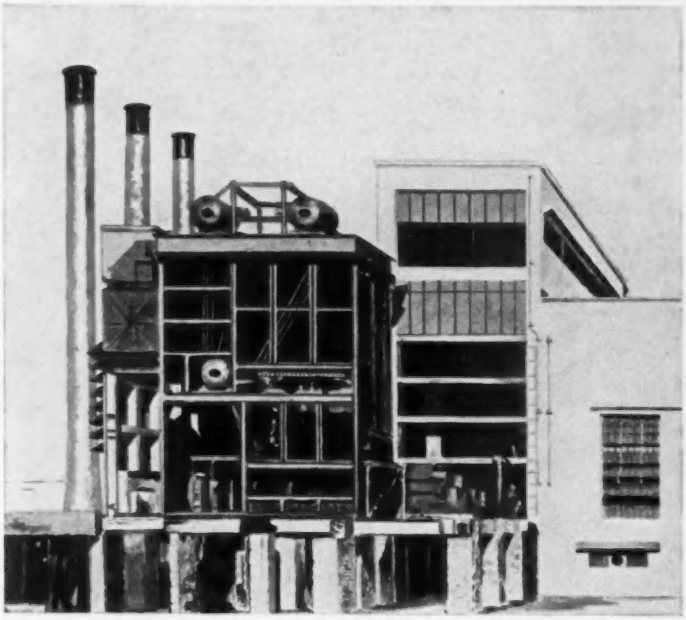

Power for India's expanding industry

CLARKE, CHAPMAN & CO. LTD. are installing two tri-drum boiler units in the new factory extensions of Messrs. Gwalior Rayon Silk Manufacturing (Wvg) Ltd., at Birlagram, Nagda, M.P. Two identical units are also being installed in the Birla Jute Manufacturing Company's cement factory at Satna. These installations incorporate chain grate stokers for coal-firing, water-cooled front and side furnace walls, suspended arches, superheaters, economisers, mechanical draught plant and grit collectors.

Evaporation: 50,000 lbs. per hour. Steam pressure: 400 lbs. per sq. in. Steam Temperature: 770° F.

CLARKE, CHAPMAN & COMPANY LIMITED
Victoria Works · Gateshead, 8
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Clarke Chapman

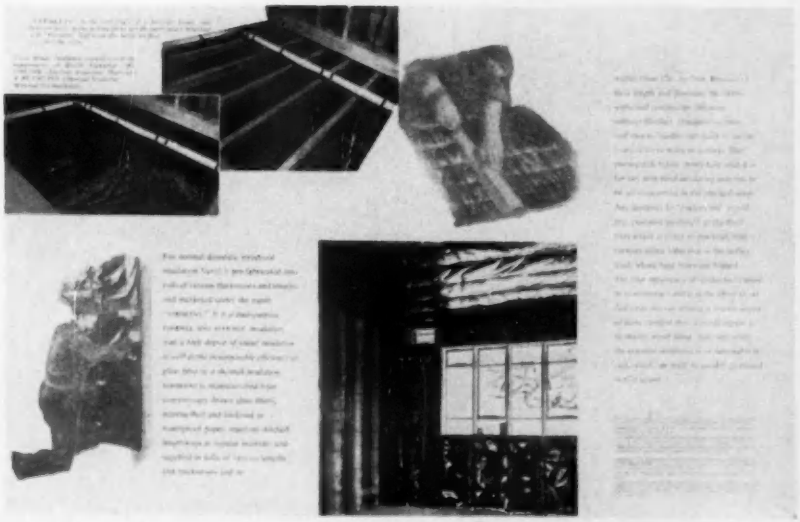
LONDON Dunster House, Mark Lane, E.C.3.
GLASGOW 116, Hope Street, Glasgow C.2.
MANCHESTER 8, King Street, Manchester 2.

CBW/V6

"Just a lot of Fuddy-Duddies!"

" It's a wonder they don't still ride in horse-carriages ! Here we are, limping along with the same old insulation methods we've had for years—and then they grumble about heavy fuel bills ! I'm going to tell 'em straight it's high time they got a really modern insulation system . . . it's high time we got in touch with Versil. . . . "

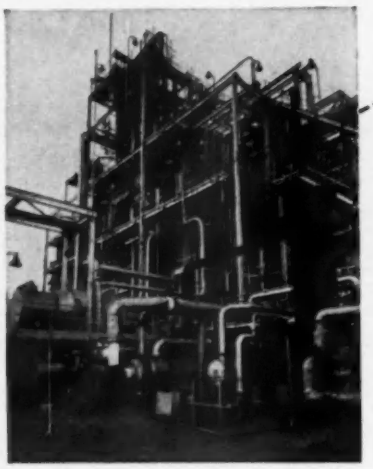
And—give them credit—they did ! The result was remarkable . . . an illustrated brochure showing the whole range of Versil glass fibre insulating materials and services is available on request. Please write to Versil Limited, Rayner Mills, Liversedge, Yorkshire. Telephone Cleckheaton 2571/3.



A " spread " from the new Versil publication — THERMAL INSULATION

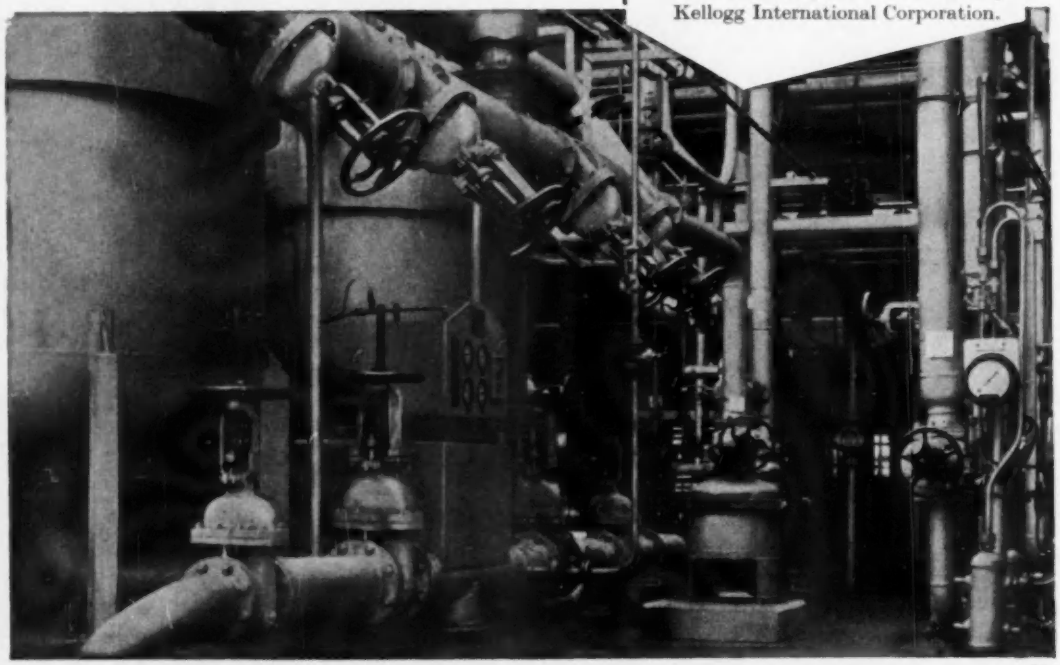
What You Need Is Versil

THE GLASS FIBRE INSULATION



Once again, valves by Crane

The new Olefine Plant—the second of its kind—has been built in the heart of Wilton Works for the Billingham Division of Imperial Chemical Industries Limited. Here important raw materials are manufactured for the other I.C.I. plants; and here working under arduous conditions (extremes of temperature) are many Crane valves. As on the first Olefine Plant, this new plant has Crane steel valves up to 16 inch. Proof once again of industry's reliance on Crane's dependability and performance. A reliance based on modern production methods, individual factory testing and high grade materials which go into every one of the Crane products. This Plant was designed and installed by Kellogg International Corporation.



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CRANE VALVES OF BRONZE, CAST IRON & CAST STEEL

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Branches: Birmingham, Brentford, Bristol, Glasgow, London, Manchester

Sludge in oil storage tanks consists largely of an oil-water emulsion that results in wasted fuel. FUELSLIP fuel oil additive breaks up existing sludge formation. The reclaimed oil is put to good use whilst the combustible elements of the sludge are taken to the burner and turned into heat.

But the advantages of using FUELSLIP only begin here! FUELSLIP is the only additive to contain a combustion catalyst which makes it possible to burn *completely* the by-products of incomplete combustion and so eliminate their binding action on carbonaceous matter. In this way the formation of harmful deposits is prevented. FUELSLIP in fact, gives you complete fuel efficiency—and that means fuel economy.

FUELSLIP is more than a product—it's a comprehensive technical service. Extensive research laboratories back up the careful and individual consideration of each user's particular problems. Results are effected not by a standardised product but by formula modification of that product. Slip Service ensures that *you* make the most of the fuel that *you* burn.

We shall be pleased to provide you with fully descriptive literature and give you the name of your nearest slip distributor. There are slip Agents all over the world ready to advise and serve your overseas interests.

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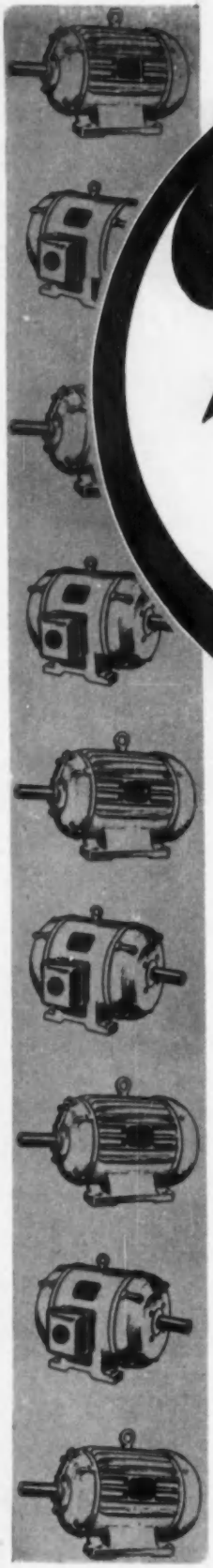

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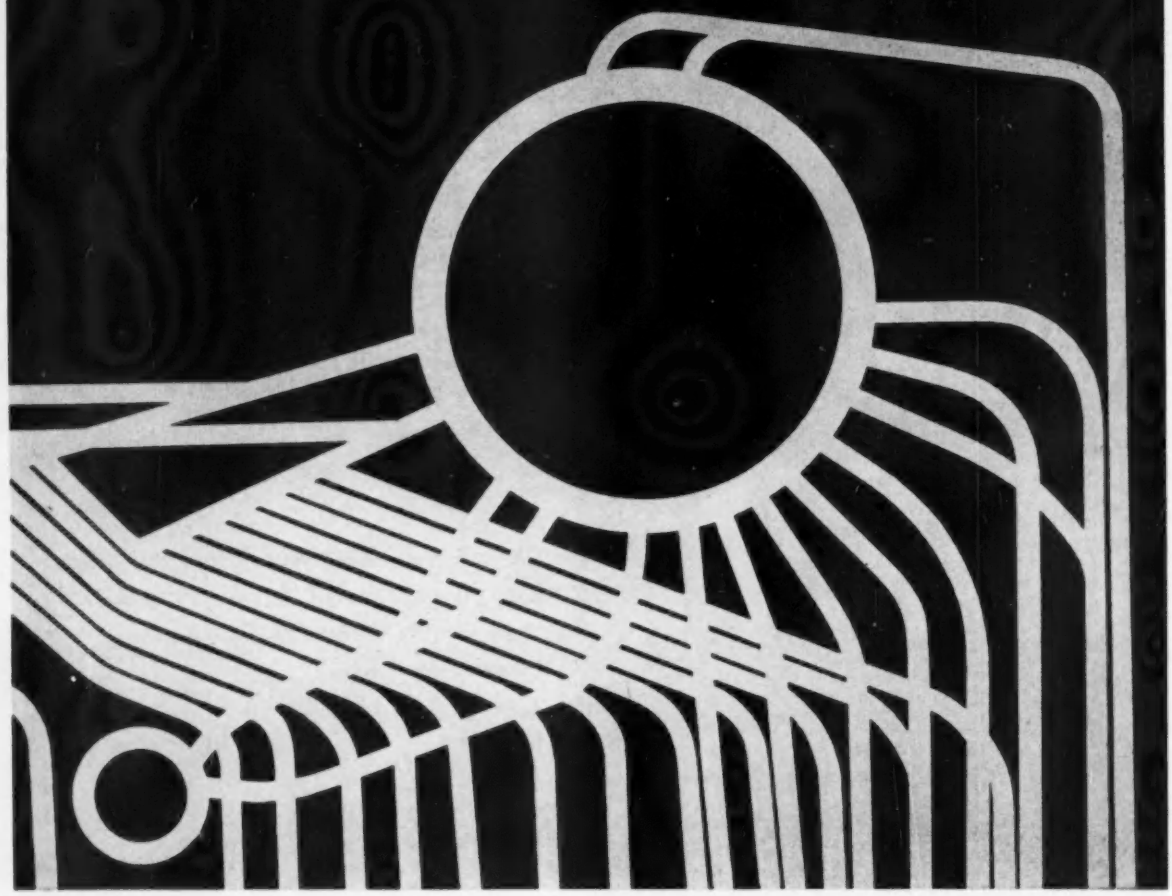
water-tube boilers



We build water-tube boilers of Foster Wheeler designs for outputs between 20,000 and 1,000,000 lb. per hour at steam conditions up to 2,350 p.s.i.g., 1,050°F, with or without re-heat, fired by liquid, solid or gaseous fuel. They are generously designed to maintain high efficiency over prolonged steaming periods.

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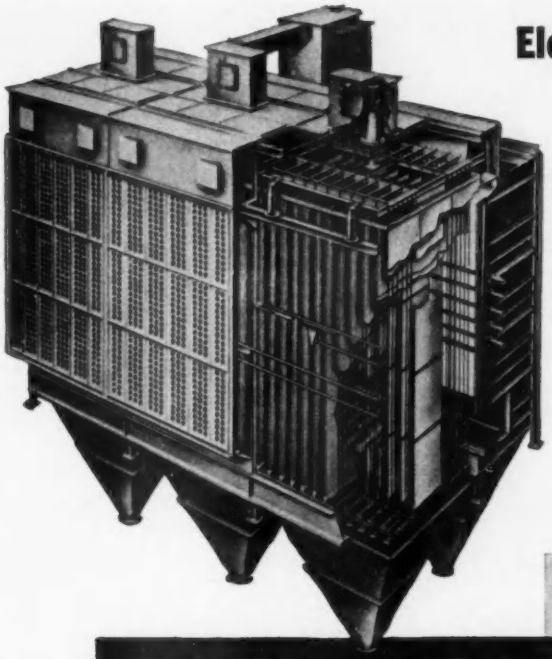
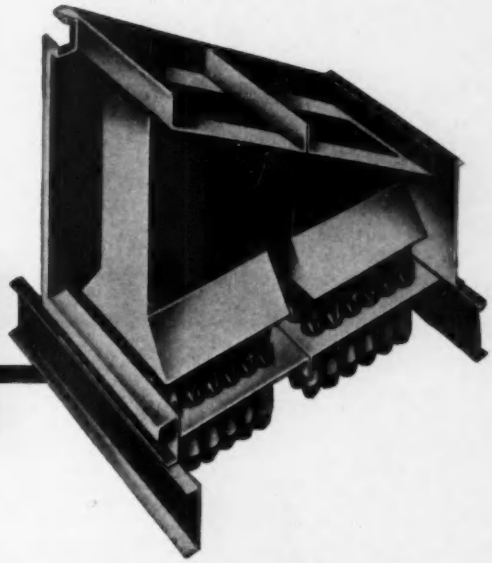


Electrostatic Precipitators

Made under licence from the Aerotec Corpn., U.S.A., these precipitators have an extremely high collection efficiency, low current consumption and many novel design features including screen-grid type collecting electrodes which minimise re-entrainment and consequent emission of dust. Manufactured in several combinations of width, height and length to suit available space in existing plants or most efficient usage of building volume in new constructions.



PD–KB

Multitubular Dust Collectors

Here is a dust collector which satisfies the ideal requirements of steam generator designers. It has a high collection efficiency at moderate resistance; maximum freedom from dust erosion; accessibility for maintenance and service; simple, low cost erection; flexibility of arrangement to meet space availability conditions. These collectors can be used in series with electrostatic precipitators and can be designed to match the precipitator inlet.

Induced & Forced Draught and Grit Arresting Fans

The product of over 75 years of experience, 'Tornado' induced and forced draught fans can handle any boiler draught requirements efficiently and reliably. The type A.R. aerofoil section backward bladed centrifugal fan, with peak efficiency of 90%, is only one of the many types (another is the combined induced draught and grit arrester) produced to deal with all classes of boilers from central heating to those in the largest power stations.

for CLEAN AIR

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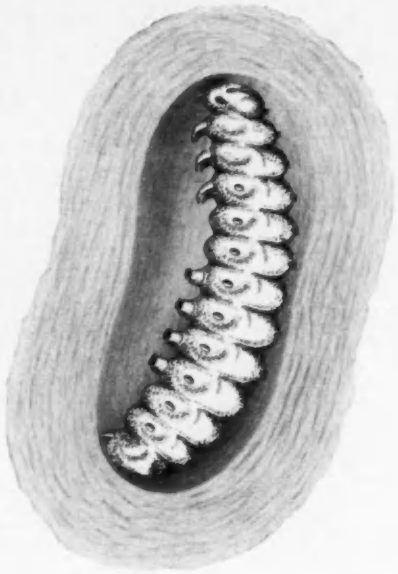
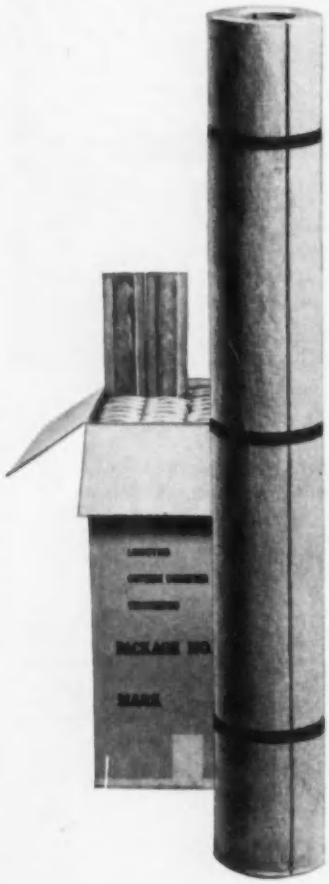
MILL MEAD ROAD · LONDON N.17
in collaboration with Prat-Daniels (Stroud) Ltd., Whitecroft, Nailsworth, Gloucester

1A.971

smaller scale insulation jobs



ROCKSIL rigid pipe sections made to fit your problem



Rocksil rigid pipe sections are manufactured from long-fibred rock wool bonded with resins. Light but strong, robust and easily fitted—an inexpensive answer to the problem of efficient insulation in the lower and medium temperature ranges.

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HEAT CONSERVATION: Hot water lines; Low pressure steam lines up to 600° F; Steam traced oil lines.
REFRIGERATION: Cold storage: Protection against frost; Anti-Condensation.
Canvas or scrim wrapped, with or without bands.
In 3 ft. lengths, thicknesses by ½" steps from ½" to 2". Uniform density 10 lb./cu. ft.
Standard Pipe sizes from ¼" to 12" bore. Also Tees, Bends, and Elbows.

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The four Howden air preheaters, with a total heating surface of 1,208,000 sq. ft. will be the largest regenerative air preheaters ever built. The four Howden forced-draught and four Howden induced-draught fans will handle a total of 3,150,000 cubic feet of air and gas per minute.

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TRANSFERRING HEAT FROM ONE FLUID TO ANOTHER

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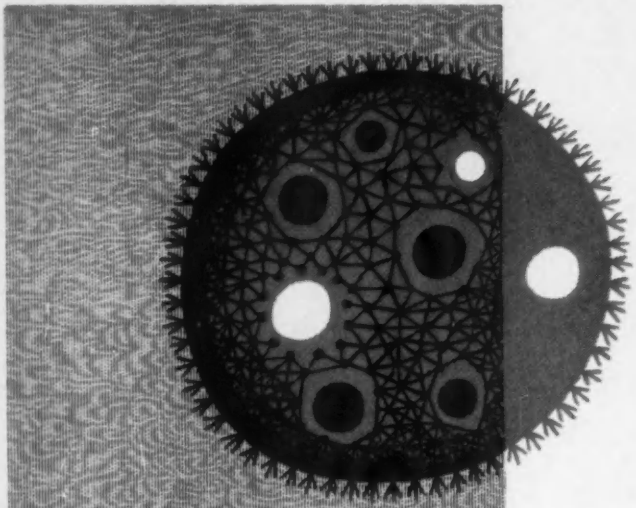

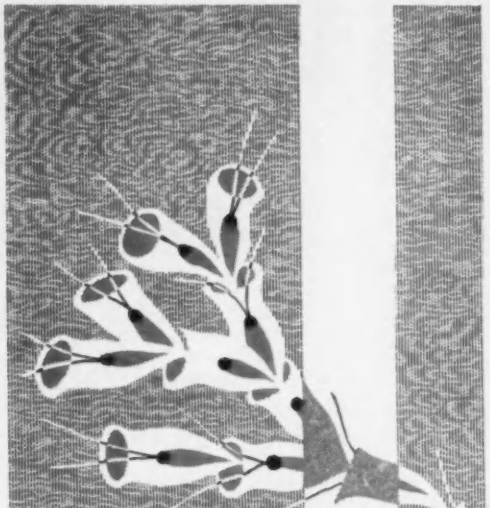

Get these out of your system!

These are some of the slime-forming organisms which cause loss of efficiency and blockages in industrial cooling water systems by fouling heat-transfer surfaces, filters, pipes, storage basins and cooling towers. Organic growths can be controlled by chlorination, a simple method which increases efficiency and reduces to a minimum the interruption of plant operation. For advice on the application and handling of liquid chlorine and hypochlorites, consult:

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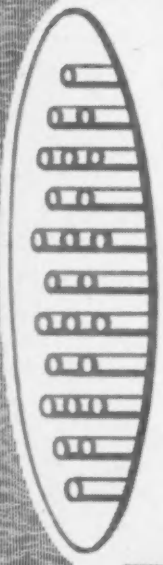

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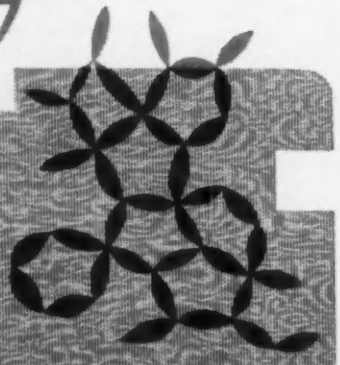

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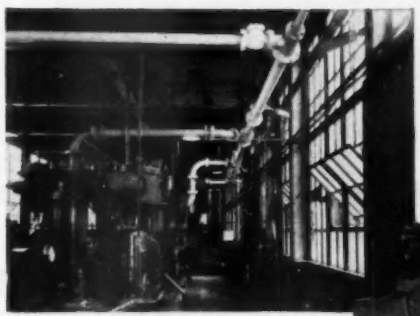
Here's the Vokes Genspring Sway Brace at work—this time on compressor branch lines at the Ipswich Factory of Crane Ltd. Designed to eliminate shock or vibration, the Non-Resonant Sway Brace is equally suitable for steam lines, exhaust lines, hydraulics and other applications. Available in nine different spring sizes, housed in two sizes of casing, Sway Braces cover an initial loading range from 92 to 1,500 lbs.
Vokes Genspring Constant and Variable Support Hangers, together with the Sway Brace, offer complete pipe support for every type of installation. Send for full details of the Vokes Genspring suspension systems.



Sway Braces in the Compressor House at Messrs Crane Ltd., Ipswich.

Close-up of Vokes Genspring Non-Resonant Sway Braces.

VOKES *Genspring* SUSPENSION SYSTEMS

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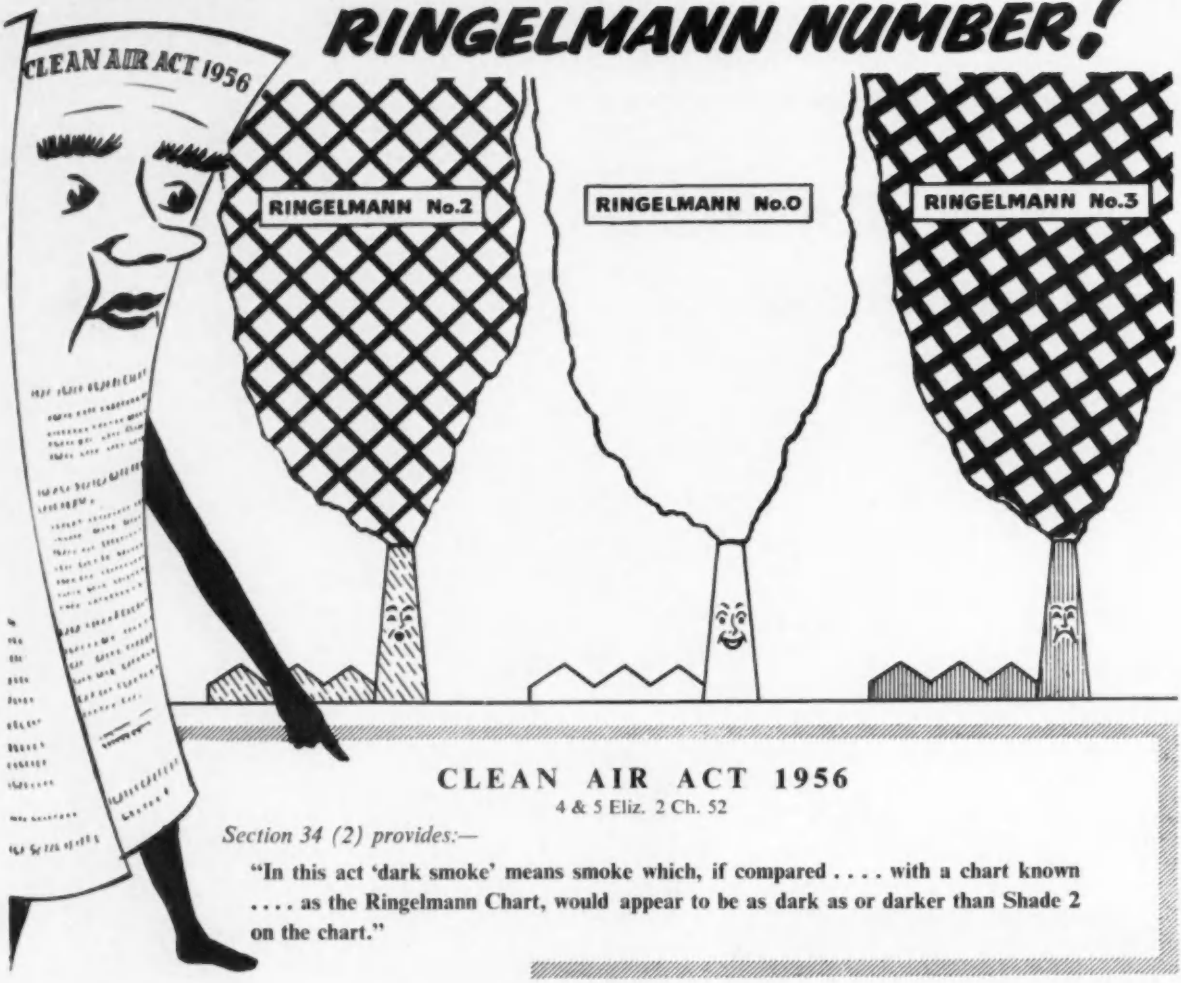

CLEAN AIR ACT 1956

4 & 5 Eliz. 2 Ch. 52

Section 34 (2) provides:—

"In this act 'dark smoke' means smoke which, if compared . . . . with a chart known . . . . as the Ringelmann Chart, would appear to be as dark as or darker than Shade 2 on the chart."

No. 3 RINGELMANN
IS A FLAGRANT OFFENCE UNDER THE ACT

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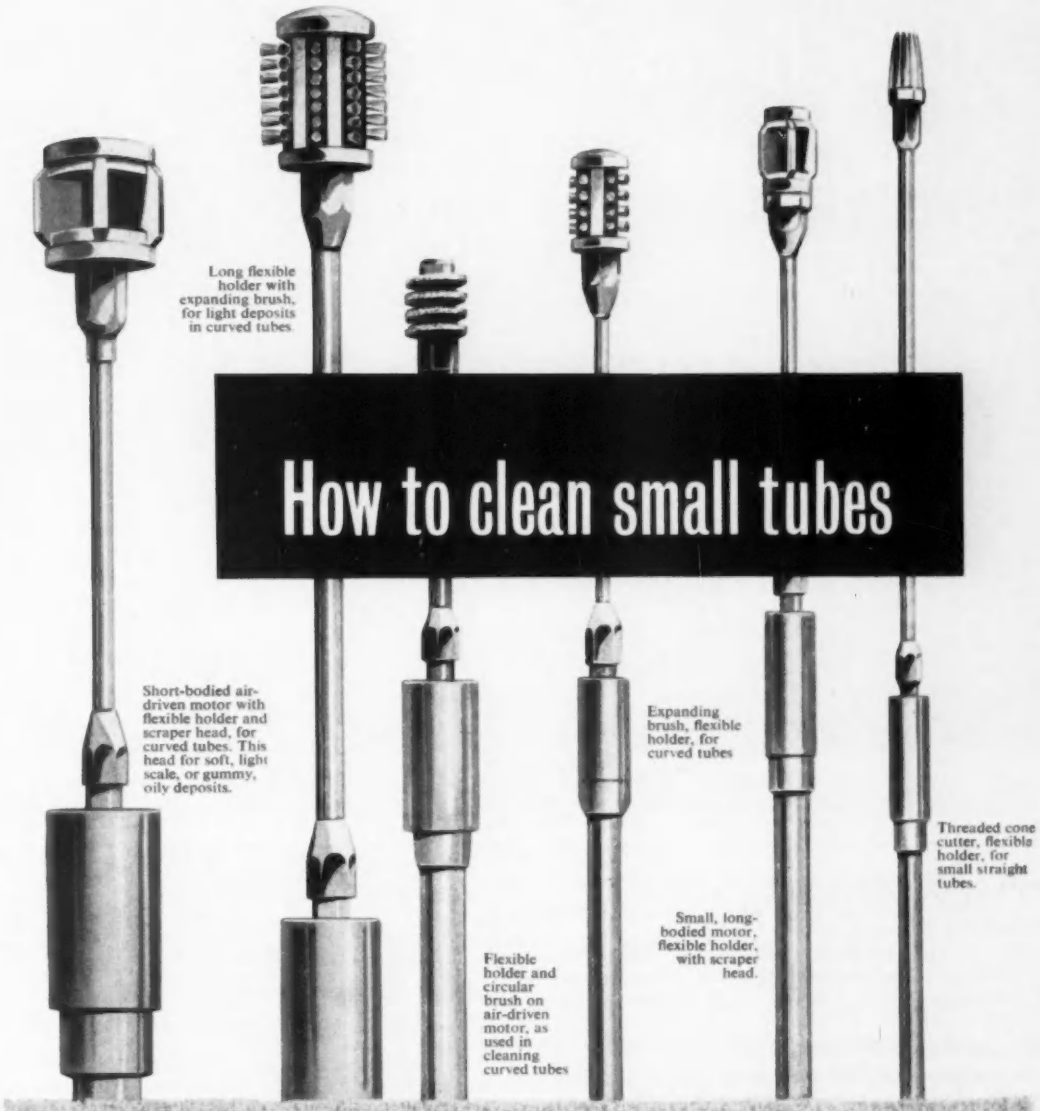

How to clean small tubes

Long flexible holder with expanding brush, for light deposits in curved tubes.

Short-bodied air-driven motor with flexible holder and scraper head, for curved tubes. This head for soft, light scale, or gummy, oily deposits.

Flexible holder and circular brush on air-driven motor, as used in cleaning curved tubes

Expanding brush, flexible holder, for curved tubes

Small, long-bodied motor, flexible holder, with scraper head.

Threaded cone cutter, flexible holder, for small straight tubes.

Long-bodied motor with universal joint and single-pin head, as used in straight tubes. This head for heavy deposits.

Long-bodied motor with direct-connected scraper head, for straight tubes.

It can be a tough business sometimes, doing a 100% job in cleaning small diameter tubes. The problem is designing a motor small enough to pass through the tube, particularly when it is curved. It is a problem that Lagonda has overcome. Look over the assortment of tools above, every one with proved performance. Write for the Lagonda Tube Cleaning Catalogue Y-48

Lagonda TUBE CLEANERS

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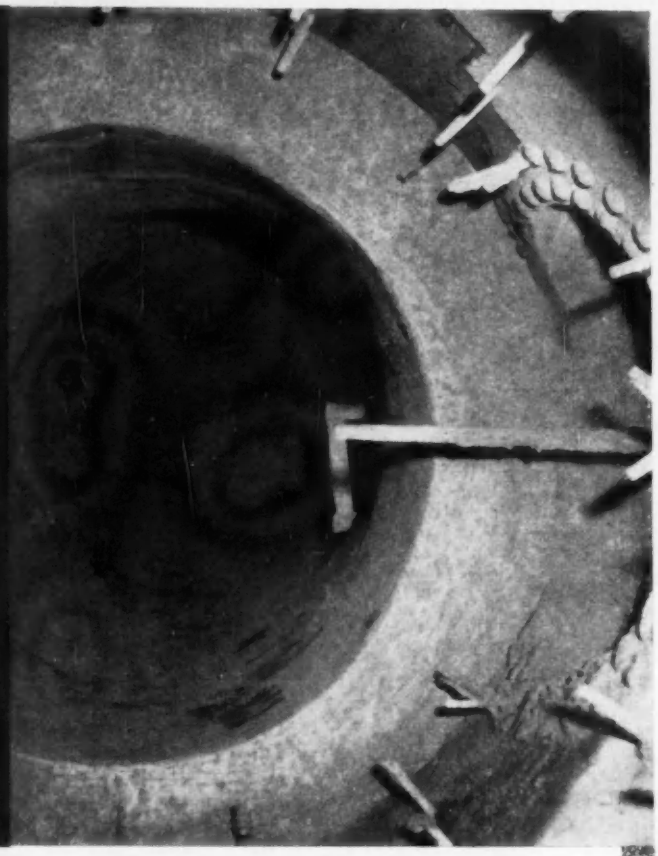
CP181

Tri-Mor Plastics and Castables make installation Easier Quicker and Cheaper



Bustle main of Queen Victoria Blast Furnace showing 'gunned' lining in Tri-Mor Dense 'Guncrete'. (Inside diameter of shell 5 feet. Thickness of 'Guncrete' lining 9 inches).
Photograph by courtesy of the Appleby-Frodingham Steel Co. (Branch of the United Steel Companies Ltd.).

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TRI-MOR *Standard Castable*

A medium texture refractory having negligible shrinkage up to 1,350° C. Suitable for casting special shapes or for monolithic structures. Limiting service temperature 1,350° C.

TRI-MOR *High Strength Castable*

A similar refractory to Tri-Mor Standard Castable, but specially developed to have very high mechanical strength over the lower temperature range. Maximum service temperature 1,250° C.

TRI-MOR *High Temperature Castable*

Suitable for face temperatures up to 1,600° C; has an extremely high resistance to thermal shock; used for cast in situ monolithic structures and for pre-cast refractory shapes; can be applied with a cement gun.

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A plastic refractory for use up to 1,650° C: low shrinkage and a high resistance to spalling. Supplied mixed to the correct consistency for installation.

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A hydraulic setting refractory with a maximum service temperature of 1,300° C. It has a high resistance to abrasion. Designed for application by cement gun, but can be trowelled.

TRI-MOR *Insulating Castable*

An insulating castable for maximum service temperatures of 1,200° C; low thermal conductivity is its main feature.

TRI-MOR *Insulating "Guncrete"*

Similar to Tri-Mor Insulating Castable but for application by cement gun.

Full details of each grade are available on request.

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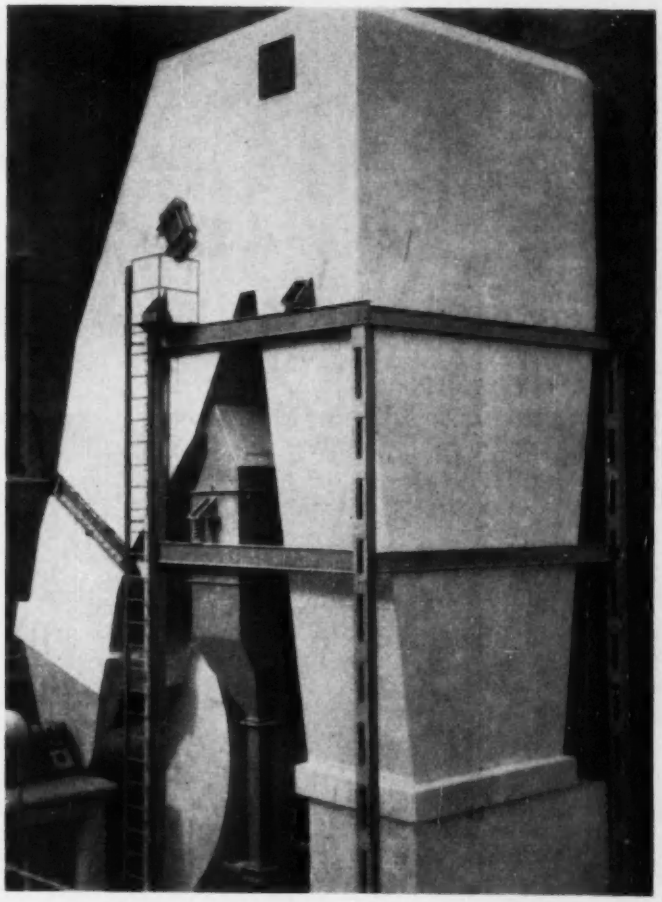
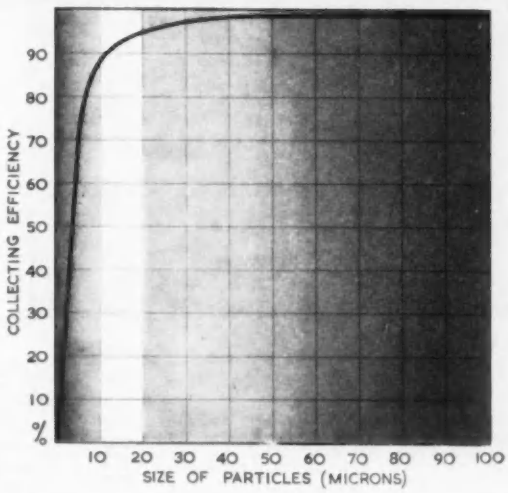
Holmes-Rothemuhle Multi-Cell Cyclone Dust Collector

A Holmes-Rothemuhle Collector installation cleaning flue gases from boilers used for space heating purposes. Capacity: 100,000 *c.f.m.*





Fractional collecting efficiency and separation.

Designed to reduce stack emissions from hand, stoker and pulverised fuel-fired boilers. The Holmes-Rothemuhle Collector is an inexpensive and efficient solution to many of the problems involved in the collection of dust and grit particles in the higher size ranges. An indication of the collecting efficiency which can be expected for various particle sizes is given in the curve on the left which is plotted for a dust density of 2 grams per c.c.

In addition to the advantages of low installation, operating and maintenance costs the Holmes-Rothemuhle Collector has the added advantage of space-saving construction which enables the collector to be easily fitted into existing flue-gas ducting

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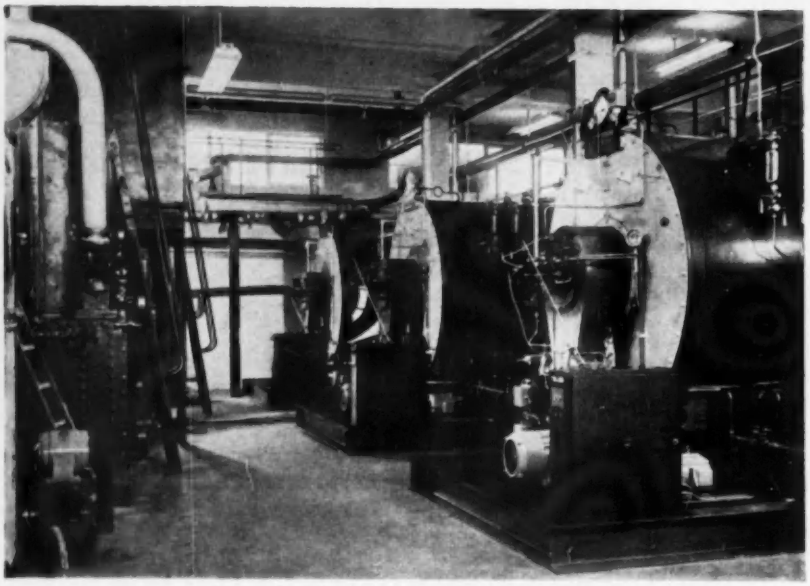

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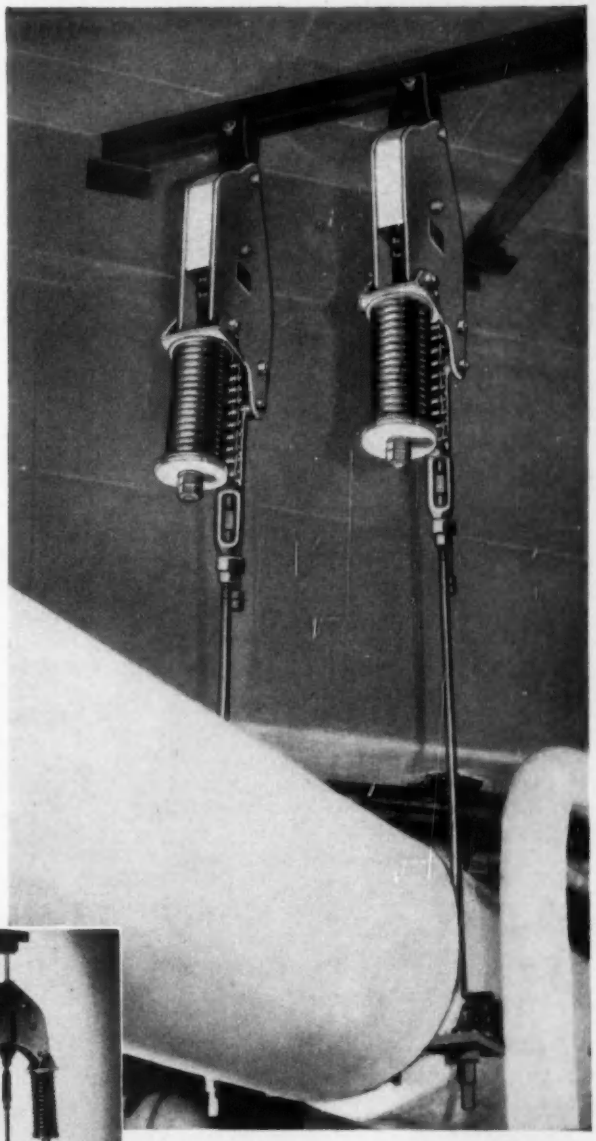
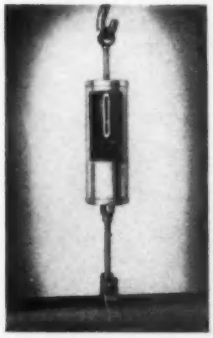


Ferrybridge " B " Power Station. Central Electricity Generating Board, Yorkshire Division. H.P. Steam pipes supplied and installed by Stewarts & Lloyds Ltd.



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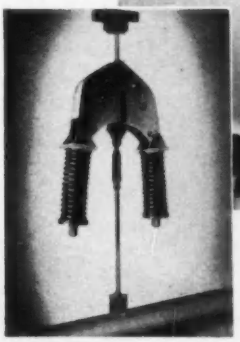
Conventional type " Con-Ten " Supports for loads up to 2 tons with a total vertical movement up to 12".



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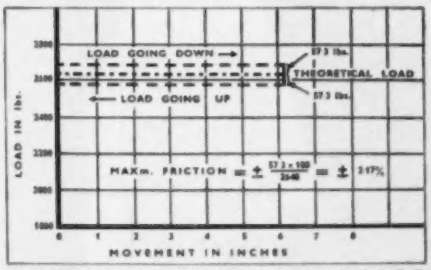

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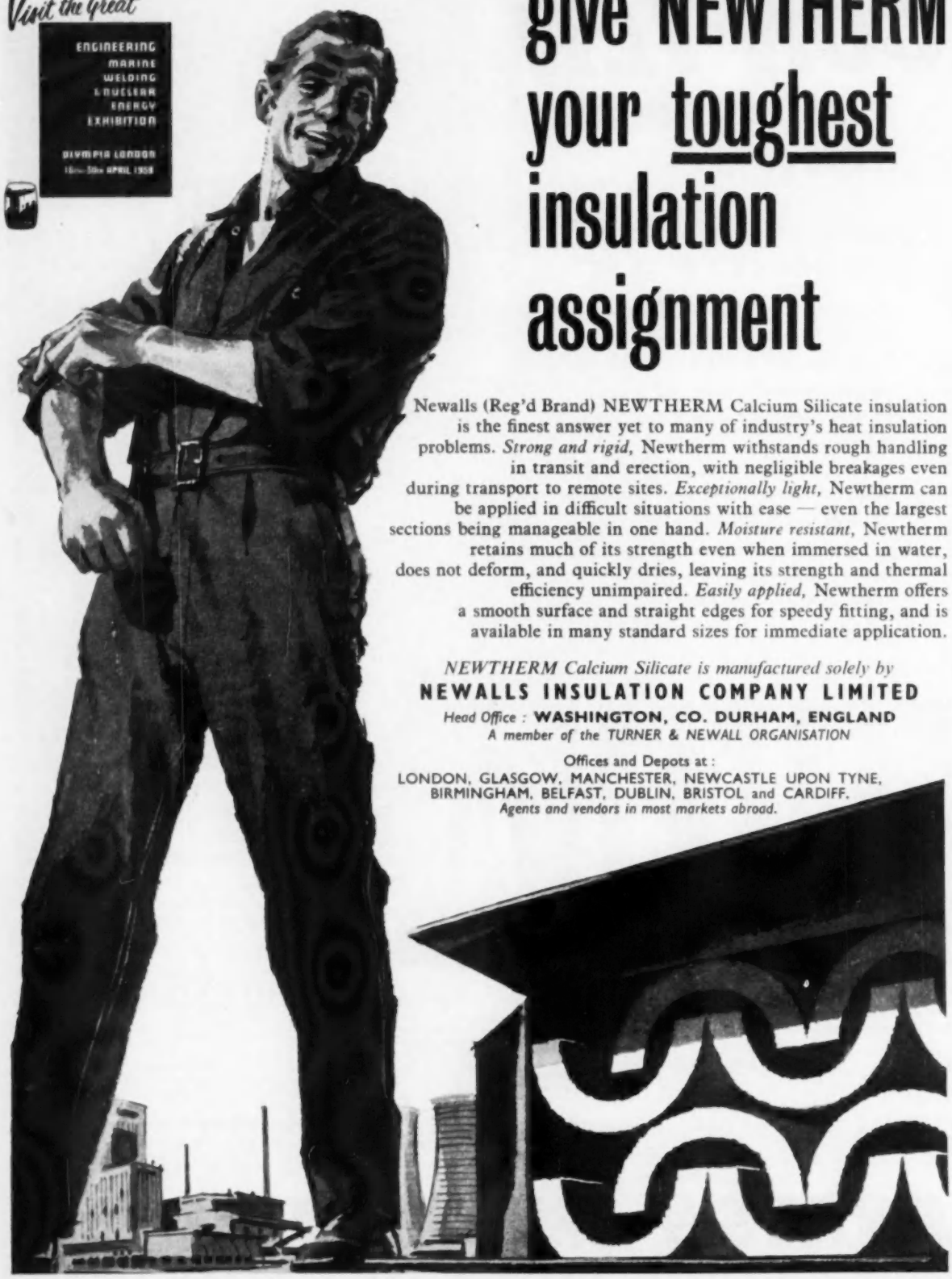

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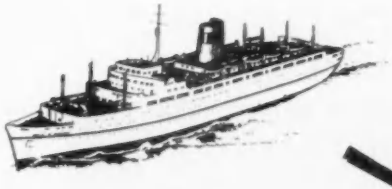

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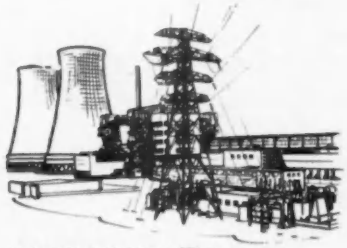

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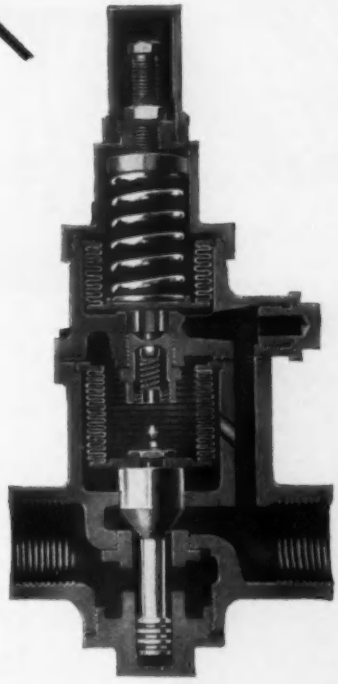

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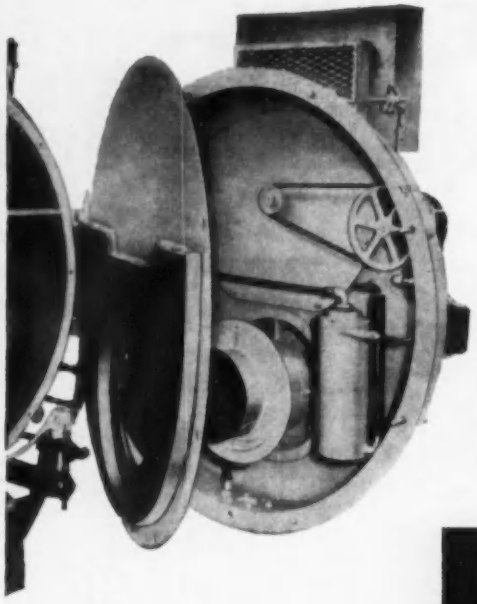

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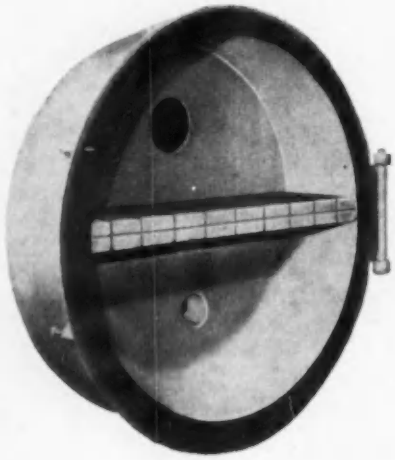

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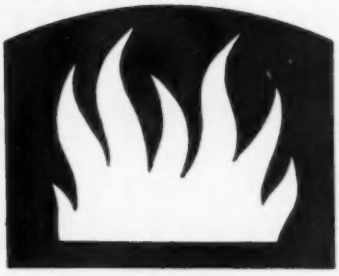

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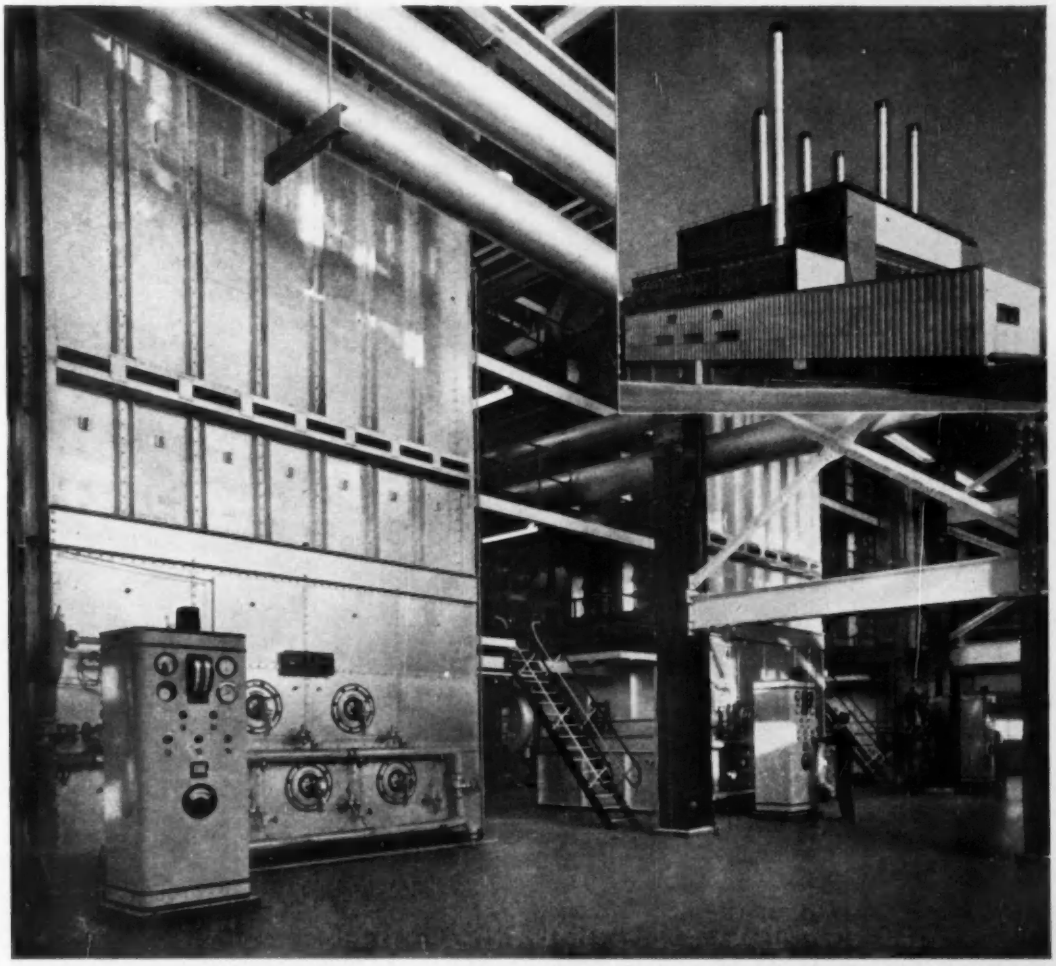

View on firing floor, with exterior view inset, of the new A.C. Block Boiler House, an integral part of the new extensions at Luton Works

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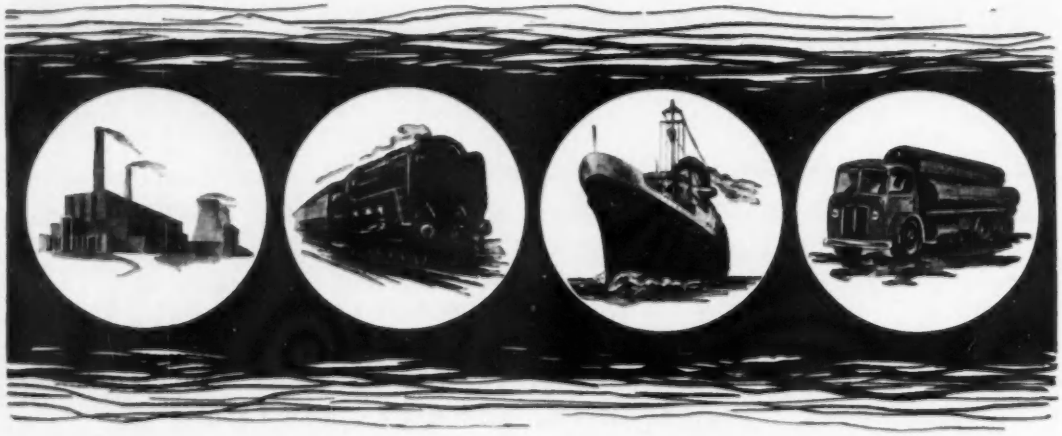

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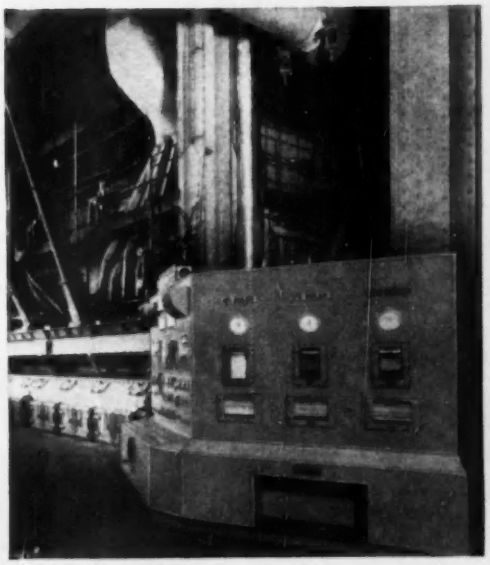
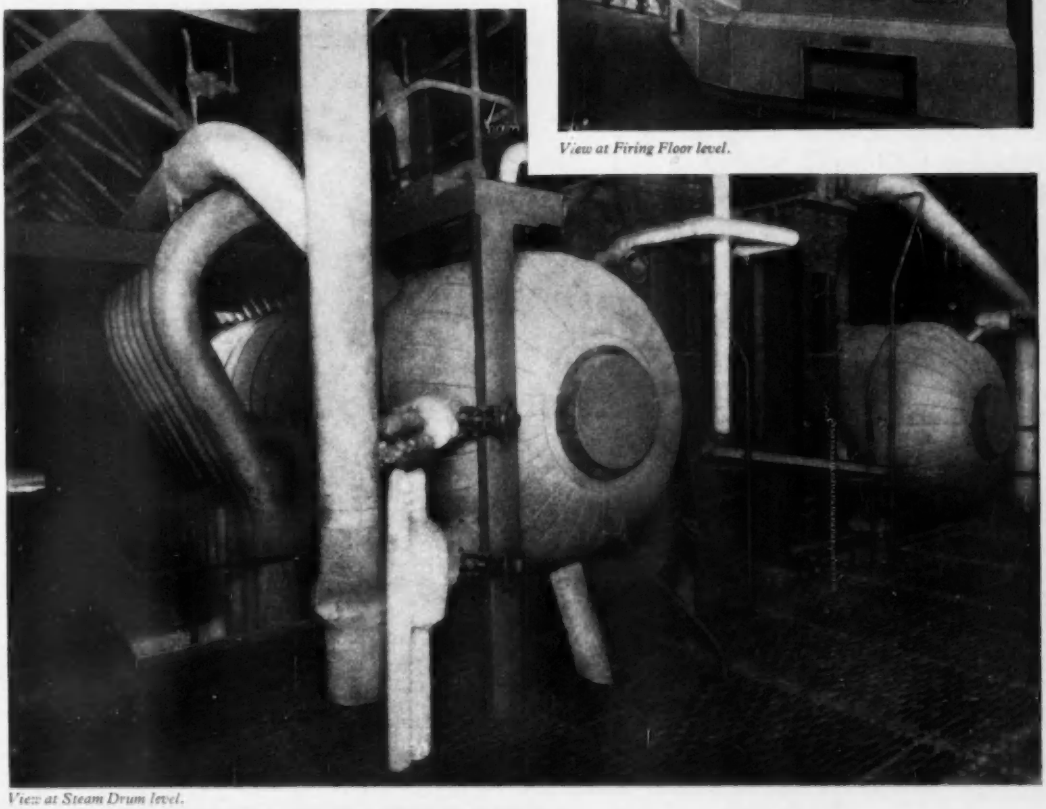


View at Firing Floor level.



View at Steam Drum level.

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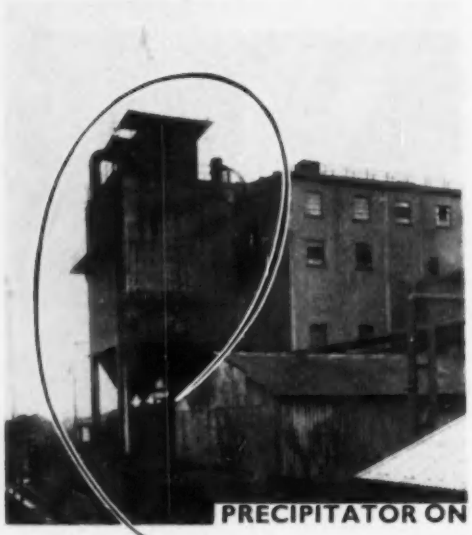

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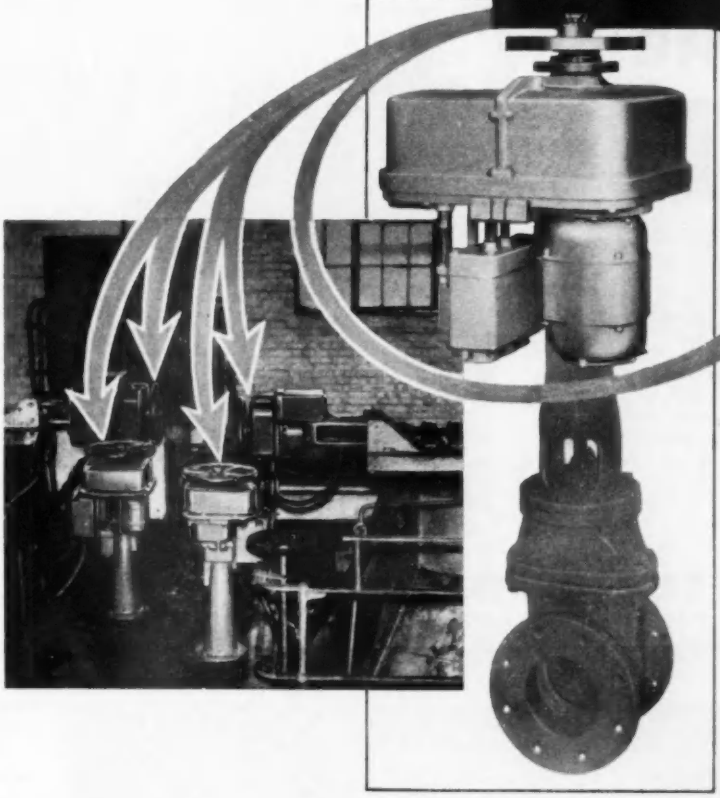

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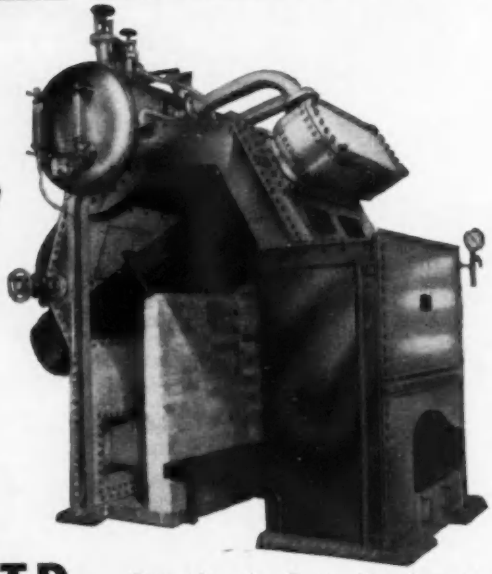

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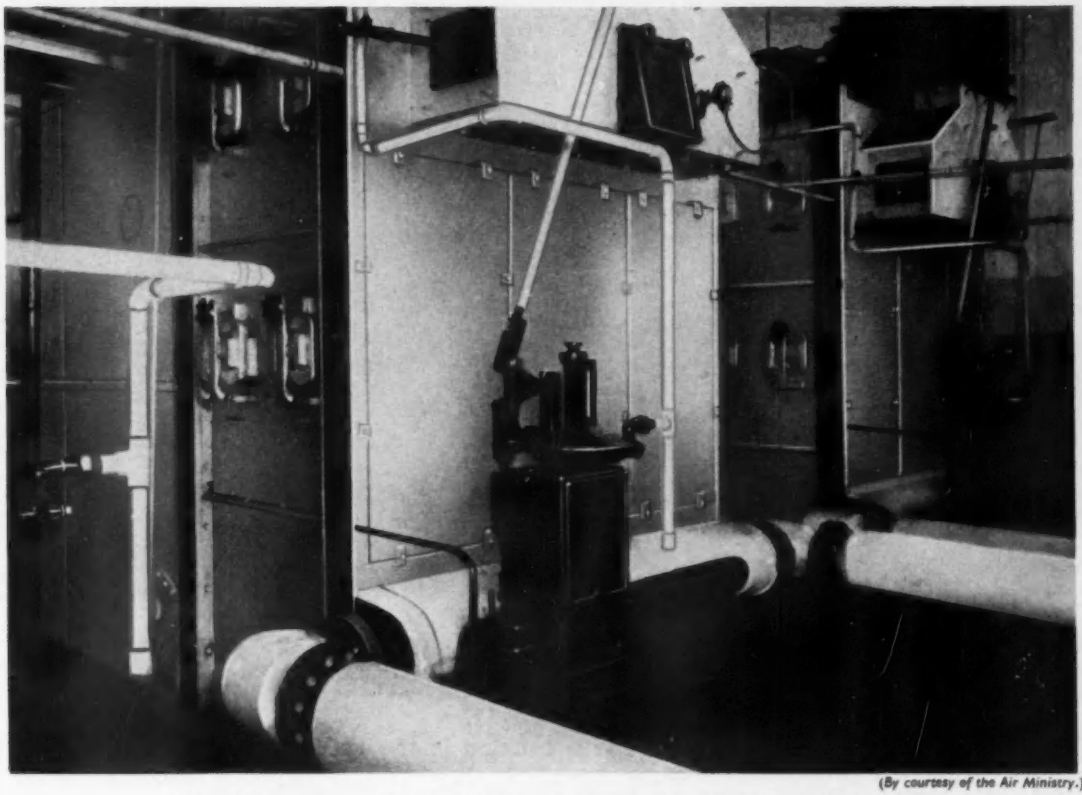

(By courtesy of the Air Ministry.)

Half rear view of two 7-million B.Th.U's/hr. BSF type H.P.H.W. packaged boilers.

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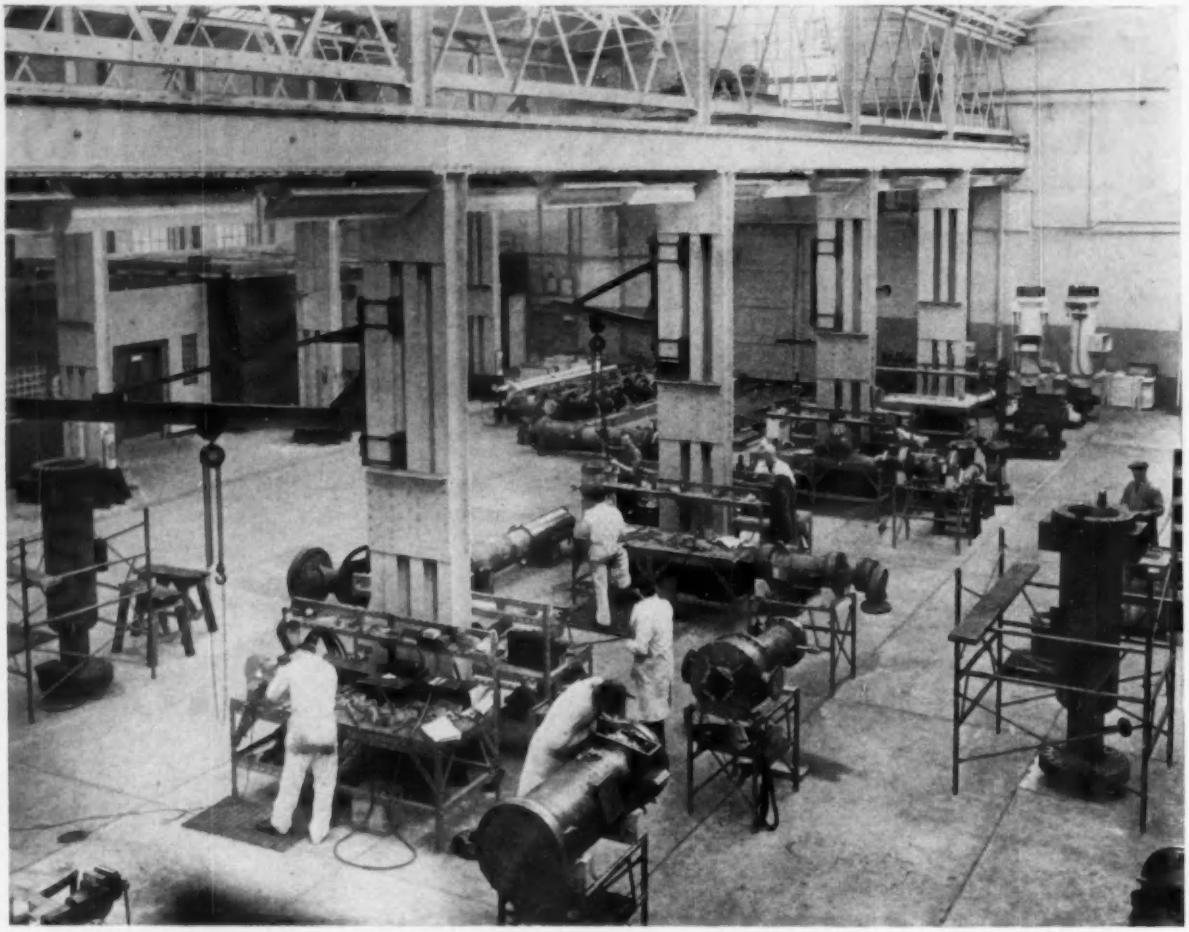

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Engineering and BOILER HOUSE REVIEW

THE OLDEST ESTABLISHED STEAM ENGINEERING PUBLICATION

FEBRUARY 1959

VOLUME 74. No. 2

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The Editor will be glad to receive and consider original contributions, correspondence, etc., of a suitable nature for publication. Stamped and addressed envelopes should be enclosed for the return of any matter considered unsuitable

Published monthly by

ENGINEERING REVIEW PUBLISHING CO. LTD.

19-20, NOEL STREET, LONDON, W.1

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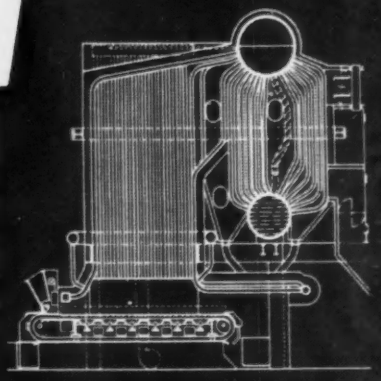
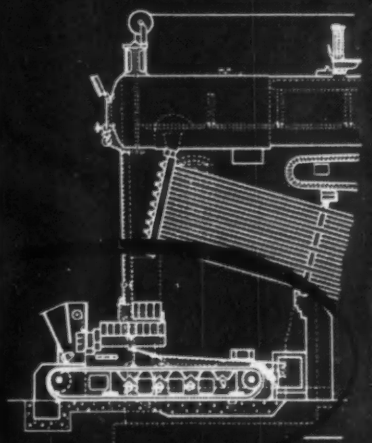
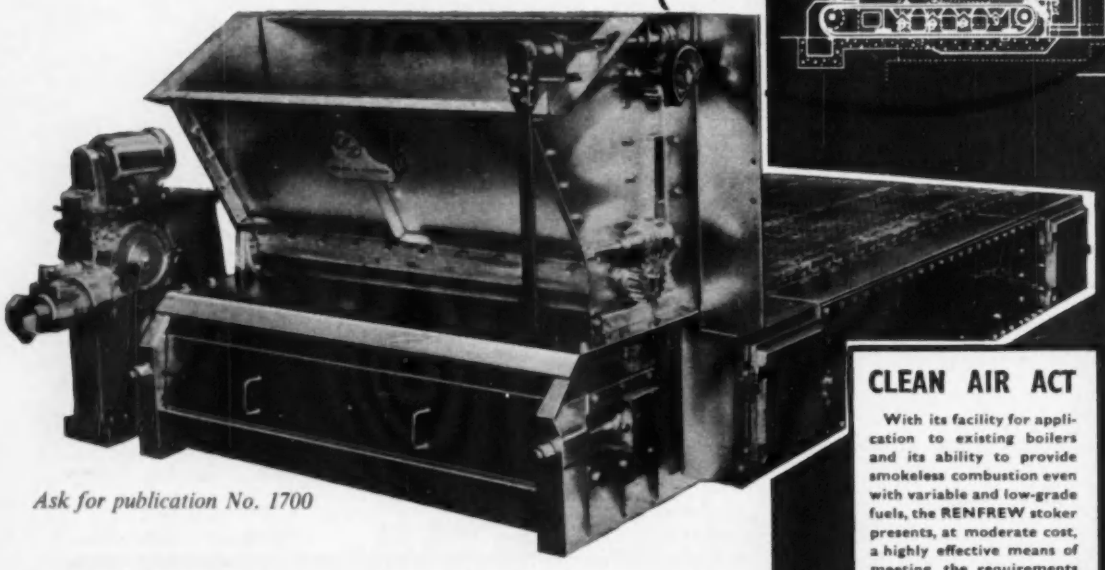




Illustrations: Above, Bi-drum boiler equipped with Renfrew stoker. Right, Renfrew stoker applied to existing, hand-fired water-tube boiler.



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Engineering and
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FEBRUARY 1959
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AVAILABILITY OF POWER STATION BOILERS

THE Boiler Availability Committee recently published another Technical Paper (No. 4), the object of which is to present the physico-chemical methods which have been developed by the British Coal Utilisation Research Association of analysing ash, slag and boiler deposits for determining the proportions of deleterious elements in the coal that lower combustion efficiency and increase maintenance costs.

In 1947 the committee published its Technical Paper No. 2, entitled " The Analysis of External Deposits from Boilers." In this particular paper, the three authors, who were experts in their own fields, showed how the maximum amount of useful information could be obtained from the analysis of boiler deposits by classical methods. Whilst these methods are accurate, they are both laborious and lengthy procedures. During the last decade, great advances have undoubtedly been made in the application of physico-chemical techniques to the rapid analysis of all types of materials. The British Coal Utilisation Research Association has studied the general application of such methods and in particular, their application to the more specialised analytical problems associated with boiler deposits

The procedures described in the present Technical Paper (No. 4) are offered more as an indication of the way in which the new methods can be applied, rather than as a standard. They do not invalidate the methods described in Technical Paper No. 2, but they are a quicker and often a more convenient alternative, involving, it appears, about only a fifth of the time with little or no loss of accuracy. The procedure depends upon the use of a spectrophotometer and of a flame photometer now commercially obtainable. Tabulated comparisons with classical methods of achieving the same results indicate sufficiently close agreement for most practical purposes, with an expenditure of a very much shorter length of time. This work appears to have a bearing on such matters as the blending of low-chlorine coals with those having a chlorine content in excess of 0.5 per cent., as is now being done by the Central Electricity Generating Board with encouraging results, more particularly with coal from the East Midlands area.

Boiler units and generating sets constitute the two main items of power station plant, and although such is the reliability of the latter that it is capable of running continuously for long periods, the boilers may possibly have to be shut down, or at least to be derated after comparatively short operational periods on account of trouble due to external deposits, and the action of corrosive condensate on the heating surfaces. The cause of deposits in water-tube boilers is a highly complicated problem involving physical, chemical and engineering factors. Laboratory research and practical work on operational boiler plant have established that the presence of sulphur trioxide in the flue gases is one of the major factors in the formation of deposits, and a good deal of attention continues to be given to the problem of ascertaining under what conditions it may be produced. One opinion holds that it is produced by dissociation of sulphates in the fuel bed; another is that it is formed in combustion chambers and in boiler passes where secondary combustion occurs, by the combination of sulphur dioxide and atomic oxygen. As combustion temperatures in the furnaces of modern boiler units may be of the order of 2,500 deg. F., and as sulphur trioxide is highly unstable at such temperatures, another opinion is that its production must occur after the combustion process has taken place and that the subsequent catalytic oxidation of sulphur dioxide on the heating surfaces is the responsible factor. Broadly speaking, boilers fired with pulverised coal may be expected to remain in commission for longer periods than stoker-fired boilers; and the deposits in stoker-fired boilers not only form more quickly, but, in general are more difficult to remove. It may be remembered that it was during the early part of the war that, on the suggestion of the then Central Electricity Board, the Boiler Availability Committee was formed, with the immediate object of securing greater continuity of service and full rated outputs from the boilers in generating stations. Upon nationalisation of the electricity supply industry in 1948, the then British Electricity Authority gave its support to the committee which is, at the present time, financed by the Water-Tube Boilermakers' Association and by the Central Electricity Generating Board, and it includes among its members, representatives of the Fuel Research Station of the D.S.I.R. and of the British Coal Utilisation Research Association. There is no doubt that the committee has met with considerable success as a result of the research work which it has organised. It is hoped that this new Technical Paper (No. 4) will prove a useful guide to those interested in the rapid and complete analysis of boiler deposits.

Points and Pointers

THE LATE SIR CLAUDE D. GIBB

Sir Claude D. Gibb, K.B.E., D.Sc., F.R.S., who was chairman and managing director of C. A. Parsons & Company Limited, and chairman of the Nuclear Power Plant Company Limited, and who died suddenly on January 15th, at Newark Airport, New Jersey, while travelling on a business journey from the United States to Canada, was well known for not only his activity and leadership in the field of power plant-engineering, but also for the leading part he took in the rapid development of nuclear power generation immediately after the war. Sir Claude, who combined a practical flair for engineering with a scientific outlook and a keen business sense, was born at Queenstown, South Australia, on June 29th, 1898. He was educated at the South Australian School of Mines, where he studied mechanical and electrical engineering, and at Adelaide University, where he took his Bachelor's and Master's degrees in engineering. During the early part of the first world war he also gained practical experience of electrical plant installation with Australian firms. In 1917, he joined the Australian Flying Corps as a mechanic, and was later commissioned as a pilot. After the war, he was appointed senior assistant and demonstrator to Sir Robert Chapman, then professor of engineering at Adelaide University. In 1923 he decided to gain further experience by coming to England. He joined C. A. Parsons and Company Limited, as a fitter at Heaton Works, but two years later his keenness and ability had been observed and he was made the senior superintendent in charge of the company's London area. Further promotion followed rapidly, as assistant outside manager, manager of the test house at Heaton, and then chief operating and test engineer, before Sir Charles Parsons, in 1929 appointed him chief engineer and a director. For the next eight years he took a leading part in turbine research and design, until in 1937 he was appointed general manager. Soon after the outbreak of the war, his sterling qualities as an organiser were recognised, and he was appointed first as engineering assistant to the director-general of munitions production, and then as deputy to the director-general. Later, as director-general of instrument production from 1941, he was responsible for an accelerated output of guns ; and as director-general of armoured fighting vehicles from 1943, and chairman of the Tank Board from 1944, he did the same for tank production. He had been appointed joint managing director of C. A. Parsons in 1943, and on his return to the company in 1945 he became chairman and managing director. The Heaton Works, which at that time covered an area of 43 acres, have been extended to 61 acres, the number of employees has increased from just over 4,000 to 7,000 persons, and the output of turbo-generating plant from 280 to over 1,000-MW per annum. In 1945, the largest machine then on order from the firm had an output of 52.5-MW, while last year an order was received for the supply of the largest machine in the world, namely, the 550-MW set for Thorpe Marsh power station. In the nuclear power field Sir Claude played a very prominent part in the discussions which led to the construction of the first nuclear power station at Calder Hall, where C. A. Parsons & Company supplied all the generating plant, gas circulators and ductwork. Similar plant was later installed at Chapelcross. In 1955, he was largely responsible for the formation of the Nuclear Power Plant Co. Ltd. Last year a collaboration agreement was signed by Sir Claude, as chairman of N.P.P.C., and Sr. Enrico Mattei, president of A.G.I.P. Nucleare, Italy, to construct nuclear power stations in Italy, and in September a contract was received to construct the Latina nuclear power station. This is the first large nuclear-power export contract in the world. Sir Claude encouraged C. A. Parsons to build a research centre devoted entirely to the investigation of matters relating to nuclear power developments. This nuclear research centre, covering an area of 6 acres, and costing over £1,000,000, is nearing completion on a site adjacent to Heaton Works. Sir Claude received many honours during his career. In 1942 he was made a C.B.E., and in 1945 a Knight Bachelor for his services during the war. In 1956 he was made a Knight Commander of the British Empire. He also received the distinction of being appointed an Honorary Doctor of Science (Engineering) of London University and Doctor of Science of Durham University. He was elected a Fellow of the Royal Society in 1946, and was awarded the Thomas Hawksley Gold Medal of the Institution of Mechanical Engineers in 1932 and again in 1956. Sir Claude was for 22 years a member of council of the Institution of Mechanical Engineers, 8 years of which was as a vice-president. The pressure of his many duties prevented him on several occasions from accepting the honour of presidency of the Institution and ultimately caused him to retire from the council.

TREVELYAN SCHOLARSHIPS

In an editorial note published in this journal early last year, we made reference to the establishment of the Trevelyan Scholarships Trust, the aim of which is to provide a number of scholarships tenable at the universities of Oxford and Cambridge. These scholarships are awarded to boys judged to possess exceptional personal qualities as well as the necessary intellectual ability. The Trust was formed after discussions between a group of industrialists, members of teaching staffs at Oxford and Cambridge and representative headmasters. The scheme is sponsored by twelve companies, thoroughly representative of British engineering and commerce, and sufficient funds have now been subscribed to permit the award each year of not less than thirty-four three-year scholarships of £450 a year over a period of five years. Sir Walter Benton Jones is chairman of the Trust. At the outset it was agreed that selection should be made by interview, supported by comprehensive reports from

candidates' headmasters, and particularly by the evidence of written reports submitted by the candidates on an "arduous and exacting task or project which they had undertaken." It was arranged that all applications would first be considered at either Oxford or Cambridge, according to the applicants' first choice, by a panel drawn from college tutors and other senior members of the university, and that their projects would be assessed by experts in the particular field covered by each project. These panels agreed upon "short lists" of candidates for final interview by a selection committee which comprised, in addition to the chairman, Sir Henry Willink, two members from Oxford University, two from Cambridge and two from industry. Final details of the scheme were made available to schools last June and, although it was realised that time was short, it was decided to make the first awards in December. Altogether, 123 applications were accepted and from these a short list of fifty-four applicants was compiled, all of whom were interviewed. The selection committee has now made awards of nineteen scholarships, ten of which are tenable at Oxford and nine at Cambridge. These awards are subject to the recipients obtaining places at the universities; the majority, it is stated, have already succeeded in doing so.

EXHIBITION OF SCIENTIFIC RESEARCH

Research is to be the key of the International Scientific Research Exhibition (ISRE) which is to be staged at Olympia, London, from October 3rd to 10th, 1959. The exhibition, to which industry and research organisations are invited to contribute, is intended to focus attention on scientific achievement, and to provide a practical demonstration to the public of the tremendous benefits accruing from technical and scientific resources. The organisers are ISRE Ltd. The exhibition has been carefully planned to reflect achievements in fields which directly or indirectly affect our well-being and everyday life, and grouped for convenience as follows:—power and industry, materials, transport and communications, health and food. It is intended that the central aisle of Olympia will act as the life-line of the exhibition and will be called the Avenue of Discovery. Bordering the avenue will be the hard core of basic research—the university laboratories, co-operative research associations and the laboratories of industry. From any point along the central avenue, the visitor will be able to trace the progress of development stage by stage, of important products arising from research items selected. For example, if the pure research concerns polymers it would be possible, as one moves out towards the periphery of the ground floor plan, to trace the development of plastics and man-made fibres leading to a variety of products. Special advisory panels, consisting of some of the leading scientists, designers and industrialists in the country, have been set up to be responsible for the impartiality of the selection of themes and the authenticity of the displays. France, Germany and the United States will also be invited to demonstrate their progress in technical and scientific research. In the gallery at Olympia, space will be reserved for firms manufacturing laboratory equipment and all kinds of scientific instruments. Another interesting feature of the exhibition is the programme of special scientific films and lectures which will be presented in the Pillar Hall Theatre. A wide range of subjects will be included and there will be something of interest for visitors of all ages and backgrounds. Special bulk bookings at reduced fees are being arranged for school and university students. Further details may be obtained from ISRE, Norfolk Street, London, W.C.2.

SECOND COURSE ON CONTROL AND INSTRUMENTATION

A second course on the Control and Instrumentation of Reactors will be held at the Harwell Reactor School from July 7th-17th, 1959, inclusive, and will be open to British and overseas students. The first course, held in October, 1958, was heavily over-booked, and a total of 98 attended. It lasted for five-and-a-half days, but as a result of the experience gained from this course, it was decided to extend the second course to nine days. The course is primarily intended for those who have a direct interest in the control and instrumentation of nuclear reactors, and it will be assumed that participants have some knowledge of the basic principles of these subjects. The topics to be treated will include:—revision of elementary reactor kinetics, control and instrumentation; automatic control of reactors and nuclear power plants; application of computers; reactor transfer functions and function analysers; neutron flux scanning; radiation detectors and their siting in reactors; reactor safety circuits; conventional instrumentation; use of transistors in reactor instrumentation; burst slug detection; spatial instabilities in reactors; and data reduction problems on large reactors. In addition to the lectures, there will be visits to zero energy and high flux research reactors and other relevant parts of the Harwell Establishment. The fee for the course will be 50 guineas, exclusive of accommodation, and application forms, available from the Reactor School, must be returned by May 7th, 1959, to:—The Principal, Reactor School, Atomic Energy Research Establishment, Harwell, Berks.

MANAGEMENT TECHNIQUE

A course designed to throw light on the role of the manager and on his personal responsibilities in our society is being held at Madingley Hall, Cambridge, from June 29th to July 25th. It is the seventh in the series organised by the University's board of extra-mural studies whose chairman is Sir Henry Willink, Master of Magdalene College, and whose members include prominent business men such as Sir Hugh Beaver, Mr. J. O. Blair-Cunynghame, Mr. A. D. Bonham-Carter, Mr. W. W. Evans and Sir Harry Pilkington, as well as leading professors and lecturers. This year's course will examine the opportunities and responsibilities arising out of the manager's relationships with members of his own organisation, with institutions such as the trade unions, with the state and with the community as a whole. The discussions will be mainly concentrated on three main topics: 1—management and the changing structure of the national economy; 2—human problems in industry; and 3—Britain's international position. The course is intended for experienced managers of industry under 40 years of age. Candidates—there are only 40 places—must be nominated by employers, who are requested to report fully on the candidate's suitability for the course. The all-inclusive fee is £120, to be paid before the course begins on June 29th.

New Steam and Power Generating Plant for Port Sunlight

EVEN before the last war, consideration was given to the construction of a central boiler plant, together with back-pressure turbines, to provide process steam and electricity to both Unilever factories, and those of other companies in the Port Sunlight area. The idea was not proceeded with because of the war, but was revived in 1949 when designs were prepared for a station comprising four oil-fired 100,000 lb./hr. capacity boilers, and four back-pressure turbo-alternator sets with a combined output of 14-MW. Construction of the station was completed towards the end of 1958, and it was officially opened by the Rt. Hon. Viscount Leverhulme, T.D., on December 17th. The first stage of the project was a pilot installation comprising two 55,000 lb./hr. capacity boilers, one 1,300-kW back-pressure turbo-alternator set, and the necessary mains for a supply of steam to a hydrogenation plant and the Stork Margarine Works. The information obtained from the operation of this plant was used extensively in the design of the plant involved in the major undertaking, construction work for which commenced in September, 1956.

Between 80 and 90 per cent. of the steam produced in the Merseyside station is supplied to ten factories within a radius of 1½ miles; and as a result, three boiler plants in Port Sunlight, and plants at Price's (Bromborough) Ltd., The British Extracting Co. Ltd., Bromborough Dock, Brotherton & Co. Ltd., Fawcett Preston & Co. Ltd., Brockhirst Switchgear Ltd., and Lloyd & Cross Ltd., will be closed, in addition to those at the Stork Margarine Works, and hydrogenation plant which ceased to operate when the pilot scheme was introduced. Two of these, one at Port Sunlight and the other at The British Extracting Co. Ltd., will, however, be retained as standby plant.

The site of the new station was selected because of its central position, close proximity to the river Mersey for drainage, availability of railway facilities should these be required, and for the good bearing quality of the ground, which comprises solid sandstone rock at a depth of approximately 8-ft. The main building covers an area of approximately 35,000 sq. ft., and is of steel-framed construction, clad with brickwork. The roof is of "Bison" pre-stressed and pre-cast concrete units covered with vermiculite insulating screed and asphalt, except directly above the boilers, where aluminium decking with two layers of felt is used. The main contractors for this and other civil engineering work in connection with the station were J. Jarvis & Sons Ltd., while Edward Wood & Co. Ltd. were responsible for the structural steelwork. Two reinforced-concrete chimneys, 250-ft. high, and lined with Nori acid-resisting bricks were constructed by Associated Settings & Chimneys Ltd.

Fuel-oil supplies

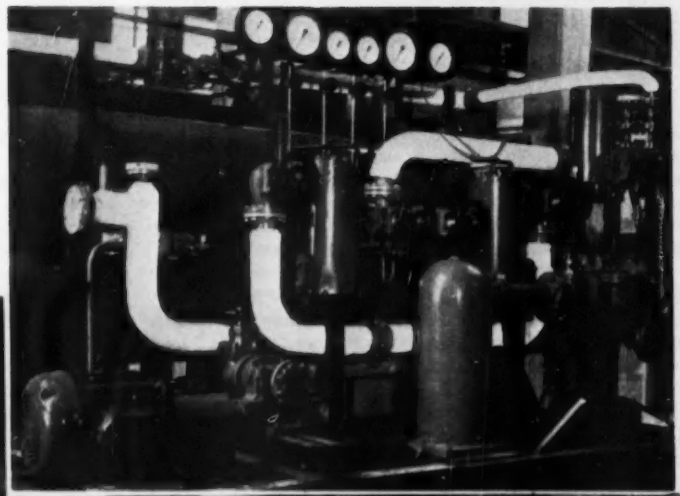
Fuel-oil supplies are received from the Shell company's Ellesmere Port pumping station some 3½-miles away, through a 4-in. diam. underground pipe-line, and delivered into either of two 5,500-ton capacity storage tanks, or alternatively to three 160-ton capacity service tanks. The rate of pumping can be varied between 4- and 25-tons/hr., the oil being pre-heated at the pumping station to avoid any risk of it becoming too viscous. Oil transfer pumps, supplied by Hamworthy Engineering Co. Ltd., are provided for transferring oil between the storage and service tanks, which were manufactured by Whessoe Ltd. William Kenyon Ltd., Dukinfield, were responsible for the thermal insulation work on these tanks, and also that for the pipework, in which it is necessary to maintain the temperature of the oil at 150 deg. F. The fuel-oil, which has a maximum viscosity of 3,000 secs., a gross calorific value of 18,300 B.Th.U./lb., and a sulphur content of 4 per cent., is supplied to the boiler burners from two Babcock & Wilcox Ltd. pumping and heating units, each rated at 20,000 lb./hr., and each containing one electric and one steam-driven oil pump, and duplicate steam heaters.

Boiler plant

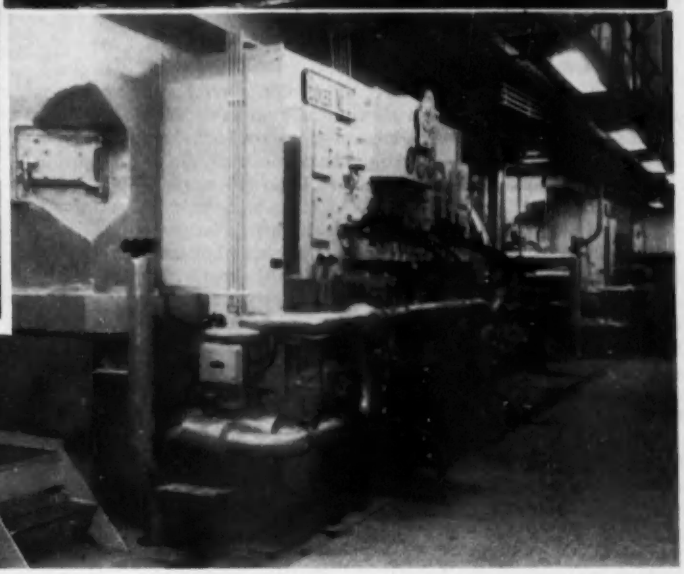
The four F.H. integral-furnace type boilers supplied by Babcock & Wilcox Ltd., are each designed for a c.m.r. of 100,000 lb./hr., at 650 lb./sq. in. and 850 deg. F., with feedwater at 250 deg. F. Each unit has a full-load oil-fuel consumption of 8,150 lb./hr., the firing equipment comprising four of the company's register-type steam atomising "Y"-jet burners. The boilers are essentially of the bi-drum type, each with an upper and lower drum

connected by rows of generating tubes. The steam drum has an internal diameter of 48 in., and the water-drum 36-in. Tubes used in the furnace and boiler are mainly of 2- and 3-in. o.d., the boiler heating surface being 8,265 sq. ft., and that of the furnace 1,700 sq. ft. The integral furnace is formed by an extended screen of water-tubes, at one side of the boiler, which form the roof and outer wall of the furnace. This screen is fed from the lower drum through the tubes forming the bottom of the furnace, and is connected back into the top drum. The end walls are similarly treated—thus the whole furnace envelope forms part of the main circulation. The main banks of generating tubes are baffled in such a manner that the hot gases leave the combustion chamber by an opening in the partition wall at the end remote from the burners, traverse the generating tubes and the superheater sections in a series of horizontal passes, and finally leave at the burner end. The F.H.-type boiler, due to its compact design, is a low-head unit, in which positive circulation is ensured by the arrangement of the heating surface, and by the use of the Babcock & Wilcox Cyclone steam separators in the steam and water drum, which perform the dual function of ensuring an output of clean dry steam, and enhancing the circulation. The arrangement of the baffles and the multiple gas passes produces a high heat transfer rate, and low leaving temperature, thus enabling low stack losses to be achieved without the need for complicated arrangements of auxiliary heating surfaces. The superheater is of the B. & W. vertical loop, self-draining type, arranged in primary and secondary sections, with a total heating surface of 3,190 sq. ft. The superheater outlet steam temperature is maintained within $\pm$ 15 deg. F. of 850 deg. F., above 70 per cent. of the c.m.r., by a Babcock surface-type attemperator, consisting of a number of U-tubes immersed in water in a pressure-vessel which is

(Right). One of the two heating and pumping units, each rated at 20,000 lb./hr., and incorporating one electric and one steam-driven oil pump, and duplicate steam heaters.



(Below). View inside the furnace of one of the boilers showing the four Babcock & Wilcox steam atomising " Y "-jet burners.



(Right). View at operating floor level, showing two of the four Babcock & Wilcox boilers, each of which is designed for a c.m.r. of 100,000 lb./hr., at 650 lb./sq. in. and 850 deg. F., with feed-water at 250 deg. F.

connected into the boiler circulating system.

Each boiler is provided with an economiser, supplied by E. Green & Son Ltd., these economisers being of the gilled-tube type, consisting of 160 elements, arranged in two banks, each 16 rows high and 10 tubes wide, and provided with motor-operated oscillating water-lances for water-washing. Non-retractable mass and multi-jet element type sootblowers supplied by Babcock & Wilcox are incorporated on each boiler together with rack-type sootblowers within the superheater section.

Continuous blowdown equipment for the boilers was supplied by Hick, Hargreaves & Co. Ltd., each plant being designed for a maximum continuous throughput of 75,000 lb./hr. at a pressure of 740 lb./sq. in., and to maintain a total dissolved solids content in the boiler water of 2,000 p.p.m. Water from the top boiler drum enters the first-stage vessel where steam is flashed at 230 lb./sq. in. pressure into the steam distribution mains. Drains from the vessel connect to a second-stage vessel from which flash steam at 20 lb./sq. in. pressure is taken to the feed-heating main. Effluent from this final stage passes through a drain cooler, and then at a temperature of approximately 85 deg. F., to waste.

The f.d. and i.d. fans for each boiler were supplied by James Howden & Co. Ltd., the former with a capacity of 37,000 cu. ft./min. at 80 deg. F. being driven by motors rated at 60/4 h.p., at 970/356 r.p.m., and the latter with a capacity of 73,000 cu. ft./min. at 445 deg. F. by motors rated at 97/4.6 h.p. at 970/350 r.p.m. All the motors were of Lawrence, Scott & Electromotors Ltd. manufacture, and are of the company's totally-enclosed, fan-cooled N.S. variable-speed "Emcol" type. The induction regulators of these motors are operated direct, being coupled to the Bailey Meters & Controls Ltd. pneumatic slave cylinders on the boiler control system.

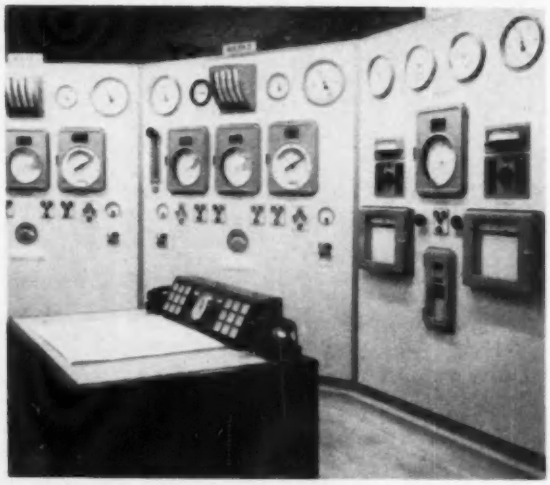
The f.d. and i.d. fans, thermal links (for fire protection), atomising steam and oil pressures, master oil valve and individual burner oil valves on each boiler are sequence interlocked to ensure safe operation.

Thermal insulation of the four boilers was carried out by The Darlington Insulation Co. Ltd., and, for the boiler walls and tops, this comprises high-temperature and 85 per cent. magnesia slabs and 85 per cent. plastic magnesia, the whole being finished with armouring compound and emulsified bitumen. The exposed parts of the steam and water drums have been covered with 85 per cent. plastic magnesia, followed by the company's special hard-setting composition.

Instrumentation and control equipment

The automatic control equipment, supplied by Bailey Meters and Controls Ltd., operates on the pneumatic system, and is designed to regulate fuel-oil flow, forced and induced-draught, and steam temperature and pressure. The equipment is housed in a central boiler control room. Should any deviation from the desired steam pressure occur, an air signal is transmitted from a master pressure controller in the direction required, and proportional to the rate of change, to effect an immediate corrective adjustment to the diaphragm-operated fuel-oil regulator valves, and also to the control drives and induction regulators controlling the forced-draught fans to vary the damper positions or fan speeds. Only the dampers operate up to 50 per cent. of the c.m.r., after which the induction regulator control varies the fan motor speed. Since the variation in fuel output in response to a given signal may differ from that of the fan output, due to the different characteristics of the dampers and fuel-oil regulating valves, a correction is necessary to maintain the required percentage of excess air. This is effected by the boiler or steam flow/air flow ratio meter. A furnace draught controller measures the actual against the required furnace pressure, and transmits a signal proportional with any deviation to the induction regulator controller which varies the motor speed, and to the control drive operating the dampers of the induced-draught fans, As in the case of the f.d. fans, the i.d. draught control is by dampers for loads up to 50 per cent. of c.m.r., and thereafter by induction regulator controller. Any deviation from the required steam temperature, measured by a recorder/controller, initiates a corrective signal which is passed via a selector valve to the control drives of the surface-type attemperators. Steam purity is continuously monitored by Dionic equipment, and is normally 2 p.p.m.expressed as NaCl.

The boiler valves and mountings are of Dewrance & Co. Ltd. manufacture; the safety valves fitted to the boiler and superheater being of the company's Consolidated "Maxiflow" full-lift type. The water-gauges provided on each boiler are fitted with Dewrance patent illuminated water-level indicators, and an external high- and low-water-level whistle alarm is also fitted to each boiler. In addition, there are numerous Dewrance pressure gauges, and forged-steel valves for auxiliary services. Feedwater regulators were supplied by Copes Regulators Ltd.



Part of the central boiler control room, showing the master control panel (right) and the panels for boilers No. 1 and No. 2.

Babcock & Wilcox Ltd. were responsible for the station pipework, which has been designed for three separate conditions—750 lb./sq. in., 850 deg. F.; 275 lb./sq. in., 700 deg. F.; and 150 lb./sq. in., 500 deg. F. With the exception of joints at valves, all joints are butt-welded; the remainder having normal face joints. Safety valves, supplied by D. Auld & Sons Ltd., are fitted to the turbine extraction and back-pressure mains, and to the pressure-reducing equipment, while separate

escape pipes are provided for each valve, and each pipe is taken to atmosphere through the station roof. The necessary pipeline valves were supplied by Hopkinsons Ltd., and the steam traps by the Drayton Regulator and Instrument Co.

The Darlington Insulation Co. Ltd. carried out the insulation work in connection with the station pipework, all pipes, vessels and tanks being lagged with 85 per cent. magnesia preformed slabs and sectional forms, finished with a ¼-in. thickness of armouring compound No. 1. Meta-Dextramite insulation was used together with the magnesia on the high-temperature steam pipes.

Water supply

Boiler feedwater is obtained from the West Cheshire Water Board's reservoir at Great Sutton, Wirral, which is supplied from the river Dee at Chester. This water is delivered through a new 14-21-in. bore main, which is some six miles long, to an underground storage reservoir of reinforced-concrete construction and of 1-million gal. capacity. Three wet-sump vertical-spindle type pumps, supplied by Sulzer Bros. (London) Ltd., each with a capacity of 66,000 gal./hr. against a head of 187.5-ft., and driven by Lancashire Dynamo & Crypto Ltd. motors rated at 85-h.p., are installed to draw water from the reservoir. Some of this water is utilised for the four alternator air-coolers, while that for boiler feed purposes is delivered to the reaction vessel in the water-treatment plant via the four turbine gland steam condensers, the blow-down drain cooler and two high-pressure feed-heater drain coolers. An emergency supply of well-water is available, and this water is also used for economiser tube washing. Condensate is used in the desuperheating equipment, this source of supply also being available for feedwater. It is pumped from the Port Sunlight factory condensate collection system to a 250,000 gal. capacity tank at the station, which also stores condensate arising within the station itself.

Water treatment plant

The water-treatment plant to supply the boilers with 100 per cent. make-up, and which has a total capacity of 46,000 gal./hr., was supplied by John Thompson-Kennicott Ltd., and is of the hot lime base-exchange type. Upon entering the plant the water temperature is raised to the operating level of 170 deg. F., by the application of steam at a pressure of 20 lb./sq. in., within a spray-type open heater, positioned on top of the main reaction tank, which is 44-ft. high to platform level, and is stated to be one of the largest of its type in the country. Special design at the base ensures a high concentration of sludge which is recirculated to the top of the tank by means of external pumps to ensure adequate concentration and application of magnesia to associate with the silica content of the raw water, which is reduced to a limit acceptable to maintain a maximum silica concentration in the boilers, in association with the continuous blowdown applied to maintain a concentration of total dissolved solids in the boiler water. The reaction tank base is also designed to maintain a sludge blanket, the level of which is controlled by automatic discharge of sludge from a sludge concentrator positioned at sludge blanket top level. Chemicals are added to the raw water automatically by plunger-type pumps which are controlled pneumatically, initiated by the differential across an orifice in the raw water supply main. From the reaction tank, the water is pumped through a battery of anthracite pressure filters before finally passing through sodium-cycle base-exchange units for complete removal of remaining residual hardness. John Thompson-Kennicott equipment is also utilised for the continuous injection of conditioning reagents into the boiler feed pump suction line and for the direct injection of phosphate solution into the boiler drums.

With the large amount of feedwater and boiler-water testing to be carried out in connection with such a plant as this, it is necessary to have an attendant on duty. Automatic control is therefore only used for those operations requiring constant attention. Periodical operations, such as regeneration of the base-exchange units, are performed manually.

Feedheating and deaerating plant

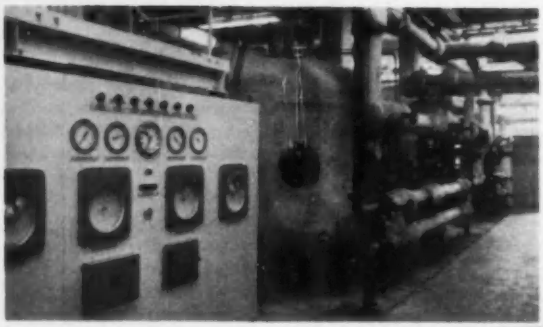
Feedheating and deaerating equipment, supplied by Hick, Hargreaves & Co. Ltd., and located in the station pipe bay, comprises two 300,000 lb./hr. capacity deaerators and two surface-type high-pressure feedheaters. The deaerators are of the vacuum re-circulating spray-type, designed to reduce the oxygen content of the feedwater to less than 0.01 c.c./litre, and to operate with a temperature of 185 deg. F., and a vacuum of 13-in. of mercury. Each unit is fitted with a surface-type preheater, and is associated with a re-circulating vessel of 9,000 gal. capacity. Feedwater is delivered to the boiler-feed ranges at 250 deg. F. via the feedheaters, which are subject to a maximum water pressure of 1,000 lb./sq. in., and are provided with automatic by-pass valves and high water-level alarms. Steam for heating is supplied from the exhaust of the extraction back-pressure turbines.

Four boiler feed pumps (two acting as standby) of Sulzer Bros. (London) Ltd. manufacture, and designed to deliver 240,000 lb./hr. of water at 185 deg. F., and 850 lb./sq. in., are installed to supply the four boiler units. The main pumps are driven by 3.3-kV electric motors manufactured by English Electric Co. Ltd., rated at 365-h.p., arranged for direct-on-line starting, either from the pump itself, or from the main control room. The two standby units are driven by steam turbines, manufactured by Mirrlees Watson & Co. Ltd., and rated at 360-h.p., with inlet steam at 230 lb./sq. in., exhausting at 20 lb./sq. in. These turbines are of the single-impulse type, with two velocity stages. They are equipped with automatic starting valves, supplied by Hopkinsons Ltd., which are set to operate when the feed pressure falls below a pre-set value.

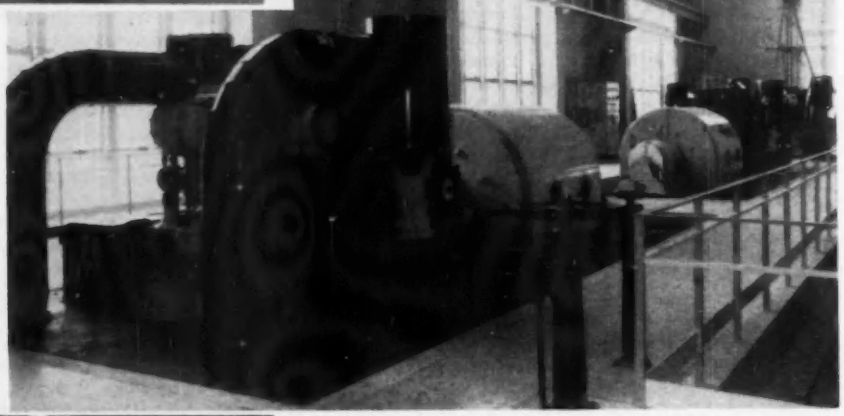
Generating plant

The station generating plant was supplied by British Thomson-Houston Co. Ltd., and comprises two 4,520-kW back-pressure primary turbines and two 2,500-kW extraction back-pressure secondary turbines. The primary machines have eight impulse stages, and are designed to pass 200,000 lb./hr. at full load, with inlet steam conditions of 625 lb./sq. in., and 825 deg. F., with exhaust conditions of 230 lb./sq. in. and 639 deg. F. The secondary turbines have six impulse stages (one of which is prior to the extraction point) and are designed to pass 152,500 lb./hr. at full-load, with inlet steam conditions of 220 lb./sq. in., and 630 deg. F. Extraction and exhaust conditions are 110 lb./sq. in., 532 deg. F., and 20 lb./sq.

in., 335 deg. F. respectively. Maximum extraction flow is 120,000 lb./hr. The attemperator control provided on the boiler ensures that a constant steam temperature is maintained from under 20 per cent. of the station load to full load. The turbine exhaust temperatures are, therefore, raised as the load is reduced, thus compensating for the increased temperature drop in the transmission mains at reduced load.



(Above). View showing part of the water-treatment plant, supplied by John Thompson-Kennicott Ltd. In the background can be seen the anthracite pressure filters.



(Right). The British Thomson-Houston Co. Ltd. No. 2 4,520-kW back-pressure primary turbine and the No. 2 2,500-kW extraction back-pressure secondary turbine.

(Below). View in the station main control room.

The direct-coupled alternators associated with the primary turbines operate at 3,000 r.p.m., and generate at 11-kV, 0.8 p.f., each set being fitted with a direct-driven single-unit exciter. The secondary turbines run at a speed of 6,000 r.p.m., and the salient-pole alternators operating in connection with these machines are driven through double-helical reduction gearing at a speed of 1,500 r.p.m., and generate at 3.3-kV, 0.8 p.f. Each set is fitted with a direct-coupled exciter and overhung pilot exciter.

Steam pressure reducing and desuperheating plant

Pressure reducing and desuperheating equipment supplied by British Arca Regulators Ltd. is installed, and is designed to come into operation automatically to maintain process steam supplies in the event of a turbine being shut down for any reason. The plant associated with each primary turbine has been designed to deliver 220,000 lb./hr. of steam at 230 lb./sq. in. and 640 deg. F., while that for each secondary turbine comprises two units designed to deliver up to 120,000 lb./hr., at 110 lb./sq. in. and 532 deg. F., and 32,500 lb./hr. at 20 lb./sq. in. and 335 deg. F., respectively. Steam temperature after the reducing valves is controlled by the injection of condensate as spray water into pot-type desuperheater vessels. Drains from these vessels pass through spray-water heaters, and pre-heat the condensate prior to injection. Adjustment to the 32,500 lb./hr. unit are carried out by local manual controls, while the remaining units are equipped with a pneumatic system for the remote control of pressure and temperature from the control room.

Steam distribution mains

Approximately five miles of pipework, in sizes ranging from 6-in. to 21-in. bore, was supplied and erected by Stewarts & Lloyds Ltd. for the distribution of steam from the new station to the various factories in the area. A maximum flow of 340,000 lb./hr. of steam for process work can be exported from the station at pressures of 230 lb./sq. in., 630 deg. F.; and 110 lb./sq. in., 510 deg. F. The design conditions for the various mains are 275 lb./sq. in., 700 deg. F., with the exception of the 21-in. main which is restricted to a temperature of 550 deg. F. To accommodate the expansion of the steam mains, the routes chosen included as many diversions as possible, but where expansion loops are used, these are normally 50-ft. square, and in the horizontal plane. The height of the mains above ground level varies from 4-ft. to 26-ft. They are carried on supports of tubular construction, and throughout the system there are eight pipe bridges, also of tubular construction, with spans ranging from 80-ft. to 140-ft. All pipe

joints, with the exception of connections for valves and orifice plates, are of the Dawson joint type with backing rings. Steam trapping is by bucket-type ¾-in. traps, fitted with internal non-return valves. Only sixty traps were required for the entire system—one trap for every 400-ft. run of piping. The necessary valves were of Hopkinsons Ltd. manufacture, and the steam traps were supplied by Drayton Regulator & Instrument Co. Ltd.

The Darlington Insulation Co. Ltd. were responsible for the insulation of the steam distribution mains. This consisted of an initial layer of 1-in. thick Meta-Dextramite slabs followed by a 3½-in. thickness of 85 per cent. magnesia, radiused and bevelled, slabs, in the case of the l.p. pipework, and a 4-in. thickness of 85 per cent. magnesia, radiused and bevelled, slabs on the h.p. pipework. The majority of the work was weatherproofed by an application of Darlington armouring compound No. 1 to a thickness of ¼-in. Expansion was provided for by circumferential breaks in the insulation at approximately 12-ft. centres. These breaks were covered with P.V.C. treated asbestos cloth to prevent ingress of water. Other portions of the work were weatherproofed with green bitumen felt in an attempt to render the pipework as inconspicuous as possible, a method which proved to be very satisfactory indeed.

The Merseyside power station is connected to the company's existing electrical system at the 11-kV switchboard in the Port Sunlight sub-station and the 7.5-MVA, 11-kV/6.6 kV system interconnecting transformers at their central power station. The station 11-kV and 3.3-kV systems are interconnected by two 5-MVA star/star transformers. Station 415-v. supplies are obtained from four 750-kVA delta/star 3.3-kV/415-v. transformers. The transformers were supplied by English Electric Co. Ltd., which company also supplied the 3.3-kV and 415-v. switchgear. The 11-kV switchgear, together with the control boards and desk, is of A. Reyrolle & Co. Ltd. manufacture. A main control room houses the 11-kV and 3.3-kV circuits and an alarm annunciator panel, together with steam system instruments and controls. A control desk carries various meters showing the volume of electricity taken from the North Western Electricity Board's supply, the turbine back-pressure and extraction-pressure regulators, the 110 and 230 lb./sq. in. reducing-valve pressure regulators, together with remote indication of pressure, temperature, and flow at strategic points on the steam system.

Babcock-Tate Electrical Sootblower Control

Equipment developed by Babcock & Wilcox Ltd. in collaboration with Jones, Tate & Co. Ltd. for sootblower control.

IN the January issue of this journal we published an illustrated description of the 180-MW Mercer Power Station, New Zealand. The six 300,000 lb./hr. Babcock & Wilcox Radiant type boilers installed at the station are fitted with B. & W. sootblowing equipment which is provided with Babcock-Tate electrical control. Space limitations prevented us from making extensive reference to this control equipment, thus we include some particulars in the following notes.

Three Babcock-Tate electric sootblower sequence control cubicles have been supplied to this station, each cubicle being arranged to operate the whole of the sootblowing equipment, including the associated steam valves on each of two boilers. The changeover from one boiler equipment to the other is effected by a "two-position" multi-pole transfer switch which changes over the whole of the outgoing circuits. This switch is electrically interlocked so that before the switch can be operated, the equipment connected has to be in a safe position—that is, the sootblowing sequence has to be completed and the steam valves actually shut.

Each boiler equipment controlled will finally comprise two steam valves, one having shut/open control only, and the other having shut/crack/open control. The crack position being available to allow of warming of the sootblower pipe lines, etc. This valve control is effected by individual controllers, the valve following the operation of the switchgear directly. In the case of the sootblowing equipment however, the control switchgear provided takes the form of a pre-selector with which the blowers actually required to operate are pre-selected by positioning the switches accordingly. The sequence is then started by a separate push-button unit. Then, providing the steam valves are full open, the selected cycle will commence.

Each boiler at Mercer may ultimately be fitted with 17 Babcock blowers, 12 of which will be of the retractable pattern, and 5 rack type, which are arranged to be electrically reversed. Blowers numbers 1 to 16 are arranged to operate in pairs in order to minimise the total blowing time—the last blower operates singly. As each head commences its operation, the timer is started. This timer is arranged to operate an alarm should the heads involved fail to complete their runs in the allocated time.

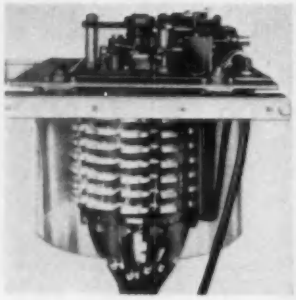
The alarm system is also arranged to give immediate indication should any of the control or power circuit fuses within the cubicle fail. Alarm is also given should the mains switch on the front of the cubicle be placed to the "off" position whilst a sootblower is actually in operation.

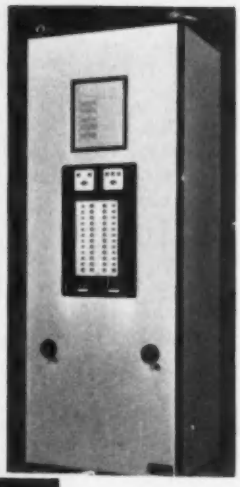
Reversal of the rack-type sootblowers is normally carried out automatically upon the blower operating the limit switch at the end of its inward travel. However, reversal of a blower can be carried out at the cubicle any time during the inward travel, by operating the appropriate selector switch. This reversal is also carried out automatically should the appropriate steam valve be moved away from the "full-open" position (either manually, or electrically), thus minimising dangerous conditions.

With the steam valve away from its "full-open" position, the normal sequence will be stopped after the head or heads which were running have completed their run. The sequence can only be re-started by once again fully opening the steam valve. After both heads of a pair have finished their respective operations, the next pair of blowers are selected and started simultaneously—but after once being started together, each blower then operates independently and stops under the control of its limit switch, but both heads again have to

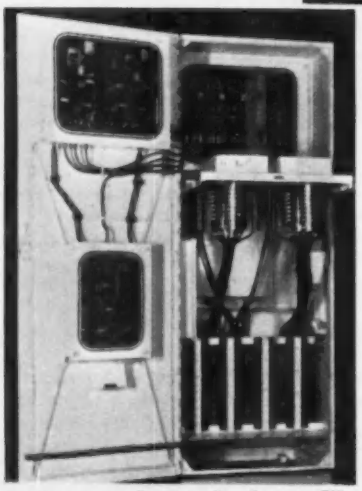
complete their respective operations before the sequence moves forward to the next pair. If only one blower is selected out of a pair, then that head alone will operate.

The unique feature of Babcock-Tate electric sootblower sequence control is that only two sets of reversing contactors are used to control the whole of the blower heads involved. This is achieved by the use of distributors which connect each sootblower in turn to the power contactors and control relays. The distributors used comprise 7-pole switch units which are operated in turn by a single arm—each 7-pole switch represents one blower. By taking connections directly from this arm to the appropriate out-going terminal strip and selector switch, and indicator unit, the wiring and control in general becomes relatively simple and easy to follow for a particular blower.





(Above). Close-up view of the sequence distributor for the Babcock-Tate electrical sequence-control showing simplicity and compactness of the mechanism.



(Above). One of the sootblower control cubicles at Mercer Power Station, New Zealand.

(Left). View looking into cubicle from rear. Each of the three cubicles at Mercer controls the sootblowing equipment on two boilers by means of a change-over switch.

The whole of the sequence-control equipment is mounted in a cubicle-type control panel of totally-enclosed dustproof construction. Provision is made for the small selector switch control panel to be separately mounted if required, to give complete remote control and indication from a convenient position and permit the minimum run of power cabling from the main contactor cubicle. Any number of blowers can be taken out of sequence by moving the appropriate selector switch to "out." The remaining blowers will operate in progressive sequence. The main hand or power-operated isolating and sectionalising valves are included in the automatic sequence, to give maximum protection to the electric and steam systems, retaining essential simplicity. With a large number of sootblowers a considerable reduction in blowing period is achieved by operating sootblowers in pairs. The sequence control is designed to meet this requirement, retaining basic simplicity.

This form of electric sequence control unit has been developed by Jones-Tate Ltd. for many other industrial applications such as the automatic control of processes or systems where several operations require to be operated or controlled in strict time sequence. Further suggested applications are—for the control of materials handling systems, transfer systems and sequence control of multiple valve systems.

FUEL EFFICIENCY LOAN SCHEME TO END

The Government's free-of-interest loan scheme to help industry provide fuel-saving plant is to end. This was announced by Sir Ian Horobin, Parliamentary Secretary, Ministry of Power, in a written answer in the Commons on January 26th. Sir Ian said the Government would continue to promote fuel efficiency, but with the easing of credit restrictions, industry should have no difficulty in financing schemes. Applications for loans now in advanced state of preparation will be considered if they reach the Ministry by February 16th. Since 1952, loans amounting to about £5 million have been made under the scheme. These have covered installations estimated to save 360,000 tons of coal a year.

The name of Incorporated Plant Engineers has been changed to **The Institution of Plant Engineers.** Since the Institution is a Company Limited by Guarantee, any change in title needs the sanction of the Board of Trade and where the desired name includes both the words "Institution" and "Engineers," such sanction is by no means automatically given. Furthermore, the Board's requirements are particularly stringent when a body holds (as the Institution does) a licence to dispense with the word "Limited." Essentially, the Board needs to be satisfied that the grant of the title will not damage the status and standards of the engineering profession as a whole or those of the established professional institutions. That permission has been granted is, in these circumstances, a gratifying recognition of the work of the Institution.

With the approval of H.R.H. The Duke of Edinburgh, president of the Royal Society of Arts, the Benjamin Franklin Medal for 1959 has been awarded to **Henry George Nelson,** M.A., M.I.Mech.E., M.I.E.E., managing director of The English Electric Co. Ltd., "for his work in scientific industrial development." The award is made annually "to individuals who have attained early distinction, with promise of future achievement, in the promotion of arts, manufactures and commerce." Mr. Nelson obtained his engineering training in England, France and Switzerland and joined The English Electric Company as superintendent of their Preston Works in 1939. In 1942 he was appointed managing director of D. Napier & Son, and in 1949 deputy managing director of The English Electric Company. He succeeded his father, Sir George Nelson, Bart., as managing director in 1956.

Mr. F. W. Gardner, deputy chairman of C. A. Parsons & Co. Ltd., has been appointed chairman of the company in succession to the late Sir Claude Gibb. **Mr. H. H. Mullens,** chairman and managing director of A. Reyrolle & Co. Ltd., and a member of the board of C. A. Parsons & Co. Ltd., has been appointed deputy chairman, and **Mr. G. M. Baker,** previously director and general manager, has been appointed managing director.

POWER PLANT ENGINEERING

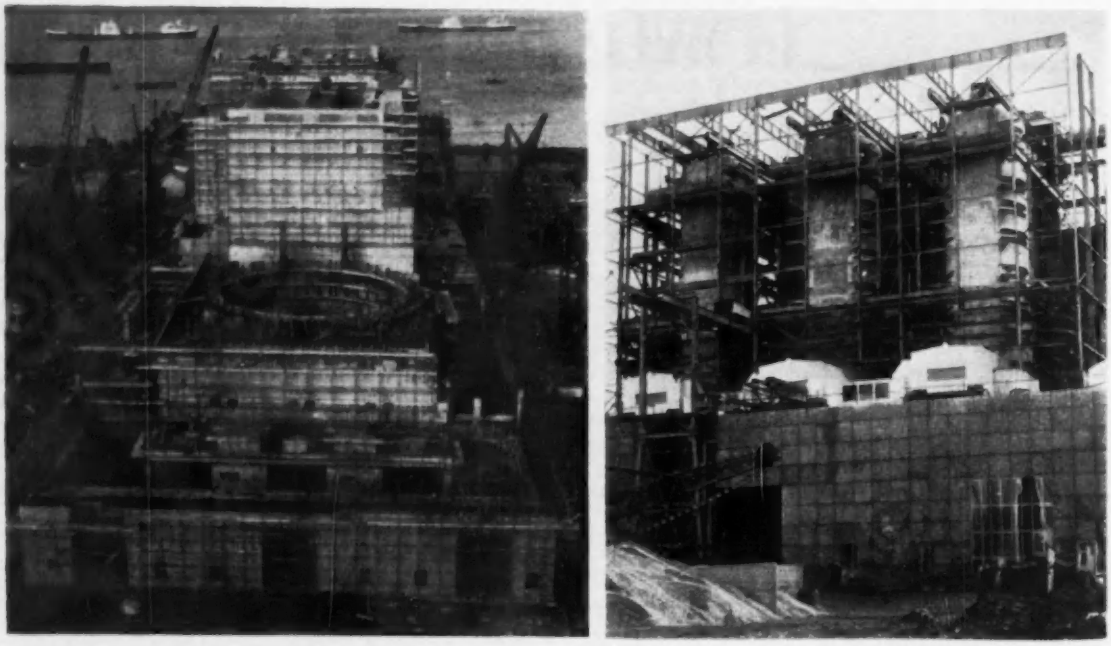
during 1958

A VERY important event affecting the electricity supply industry last year, was the reorganisation put into effect under the Electricity Act of 1957, which dissolved the Central Electricity Authority, and transferred its functions and responsibilities to the Electricity Council, and to the Central Electricity Generating Board. The chief functions of the Electricity Council are to advise the Minister of Power on matters affecting the electricity supply industry; to promote the development of an efficient, co-ordinated and economical system of electricity supply; to examine and advise on the programmes of capital expenditure; and to be responsible for certain common services, such as research, on behalf of the supply industry as a whole. The main task of the Central Electricity Generating Board is to develop and maintain the main generating and transmission system for providing bulk supplies of electricity to the twelve Area Boards in England and Wales. These Area Boards remain responsible, as formerly, for the distribution and retailing of electricity to their consumers. Last year marked the tenth anniversary of nationalisation of the electricity supply industry. During those ten years the extent of expansion and development can, perhaps, best be illustrated by recording the fact that whereas at vesting day the installed generating capacity in England and Wales was 11,680-MW, the corresponding figure at March 31st 1958, was 24,315-MW. To provide for this increase, fifty-five new power stations and seventeen "new sections" of stations have been commissioned, and forty-four extensions have been made to existing stations. To speed up the production of plant in the early stages, most of the new turbo-alternator sets were of standard 30-MW or 60-MW capacity. As the plant situation improved, however, it was possible to concentrate attention on the application of technological development aimed at increasing efficiency and economy of operation. Generating sets of large capacity were designed and installed. The first 100-MW set was commissioned at Castle Donington in November, 1956, three similar units were commissioned there in 1957 and the fifth in May, 1958. The sixth is expected to be placed in service during the summer of this year. Sets of similar capacity are in commission at Willington "A" and at Ferrybridge "B." Willington will have four of these 100-MW sets and Ferrybridge "B" three; each station being scheduled for completion this year. Sets of 120-MW, 200-MW, 275-MW and 550-MW have been ordered together with the associated boiler units. The first 120-MW set was placed in commission at Blyth "A" on December 23rd, 1958. There will be four such sets in this station.

It is planned to install the first 275-MW machine at Blyth "B" power station, to come into operation in 1962, and the first 550-MW unit at Thorpe Marsh (near Doncaster) for operation in 1963. The increase in the capacity of individual generating sets and the corresponding increase in the capacity of individual power stations have helped to keep down the capital cost to approximately £50 per kilowatt (much the same as in 1945), despite a 75 per cent. increase in the costs of materials and labour. Some of the reasons for choosing the particular ratings of 275-MW for a single-line machine (and 550-MW for a two-line machine) were outlined in the last annual report of the Central Electricity Authority, published on September 30th, 1958. In both sets, the main consideration was the size of the generator, but current development work suggested that the maximum rating, to comply with existing design requirements and road transport limits, had not yet been reached. Further, it was reported that tests made with continuously acting high-response automatic voltage regulators showed that generators could be run steadily beyond what was regarded as the normal stability point. Two advan-

STEAM GENERATING PLANT COMMISSIONED BY C.E.G.B. DURING 1958

Name of Power Station	C.E.G.B. Project Group	Turbo-Generator Plant		Boiler Plant	
		Installed capacity (MW)	Maker	Capacity in lb./hr.	Maker
Acton Lane "B" ...	Southern	1 x 30	Richardsons, Westgarth ...	1 x 240,000	Mitchell Engineering Ltd.
Blyth "A"	Northern	1 x 120	Metropolitan-Vickers ...	1 x 860,000	Babcock and Wilcox Ltd.
Bold "A"	Northern	1 x 30	Metropolitan-Vickers ...	—	—
Bold "B"	Northern	1 x 60	General Electric Co. ...	1 x 550,000	John Thompson Water Tube Boilers Ltd.
Brighton "B" ...	Southern	1 x 60	Richardsons, Westgarth ...	1 x 320,000	Babcock and Wilcox Ltd.
Castle Donington ...	Midlands	1 x 100	Metropolitan-Vickers ...	1 x 830,000	Babcock and Wilcox Ltd.
Ferrybridge "B" ...	Northern	1 x 100	C. A. Parsons & Co. Ltd. ...	1 x 760,000	Babcock and Wilcox Ltd.
Goldington	Southern	1 x 30	British Thomson-Houston ...	1 x 300,000	Clarke, Chapman & Co. Ltd.
Hams Hall "C" ...	Midlands	1 x 60	General Electric Co. ...	1 x 550,000	Simon-Carves Ltd.
Hayle	Southern	1 x 20	British Thomson-Houston ...	1 x 200,000	Yarrow & Co. Ltd.
Marchwood	Southern	2 x 60	English Electric Co.	2 x 550,000	John Thompson Water Tube Boilers Ltd.
Poole	Southern	2 x 60	General Electric Co. ...	1 x 340,000	International Combustion Ltd.
Portishead "B" ...	Southern	1 x 60	Metropolitan-Vickers ...	1 x 300,000	Mitchell Engineering Ltd.
South Denes	Southern	1 x 60	Metropolitan-Vickers ...	1 x 550,000	International Combustion Ltd.
Tilbury "A"	Southern	1 x 60	C. A. Parsons & Co. Ltd. ...	1 x 540,000	John Thompson Water Tube Boilers Ltd.
Willington "A" ...	Midlands	2 x 100	English Electric Co.	2 x 830,000	International Combustion Ltd.
16 stations including 2 new stations	3 Project Groups	19 turbo-generators having an aggregate installed capacity of 1,230 MW		17 boilers having an aggregate installed capacity of 9,100,000 lb./hr.	

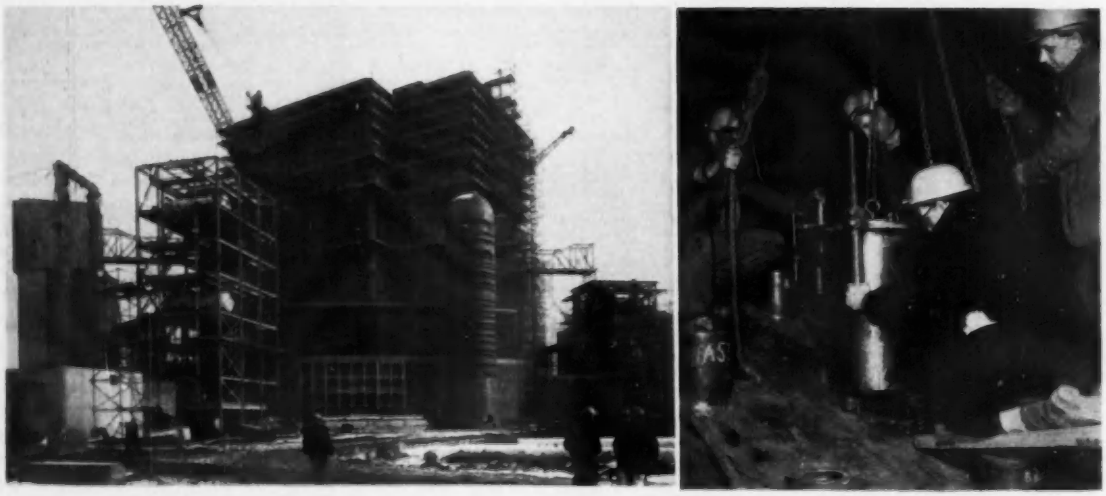


BRADWELL—*(Left). Recent view from the top of a Goliath crane showing progress made to date in construction of the two reactor buildings. (Right). Three of the steam-raising units in position at the river end of No. 1 reactor building.*

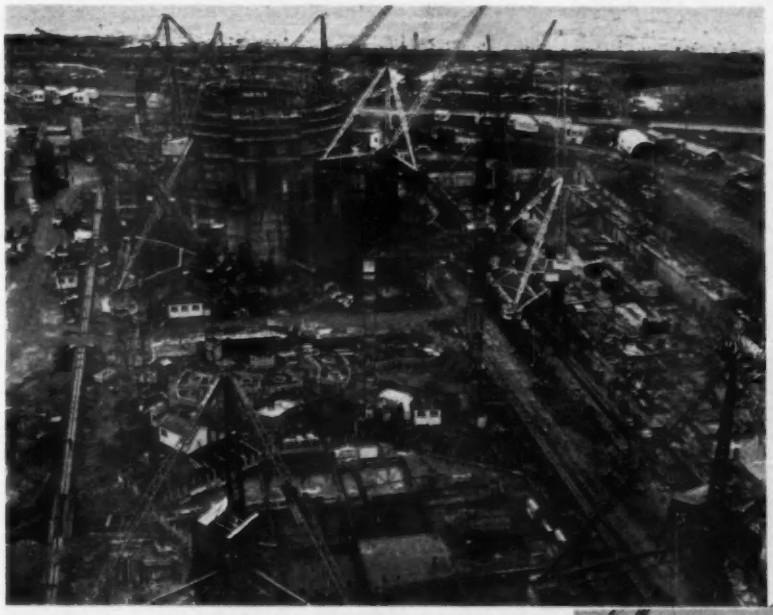
tages flowed from this conclusion. The first, was that the problem of supplying the leading power factor requirements of the 275-kV super-grid during periods of low system load would be simplified. The second, was that consideration could be given to the possibility of relaxing the existing requirements for inherent generator stability with the prospect of obtaining increased ratings from a given size of generator rotor. Single-line generators of ratings well above 275-MW are therefore considered to be practicable. In fact, a 300-MW set is already projected for installation at West Thurrock power station.

During 1958, the Central Electricity Generating Board installed new generating plant giving an additional output capacity of 1,154-MW. This total is smaller than previous annual totals. It conforms with the programme planned five years ago which took into account plant outstanding from earlier years, and with the decision

BERKELEY—*(Left). On the left of this view can be seen the completed housing for one of the heat-exchangers, and the constructional steelwork erected around a second unit. A third heat-exchanger is shown in position on the right. In the background are the No. 1 and No. 2 reactor buildings. (Right). A charge-tube boss being lowered into position for welding to the top dome of No. 1 reactor vessel.*

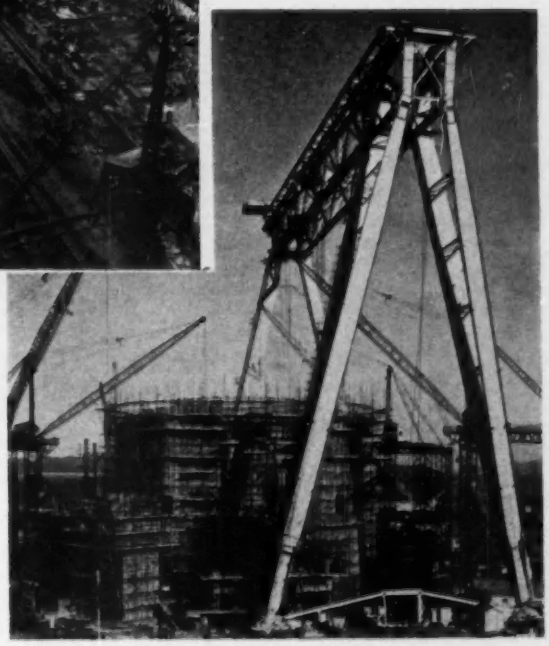


of the Government in 1953 to give priority to export orders for power station plant. Altogether, nineteen turbo-alternator sets, with an aggregate installed capacity of 1,230-MW and seventeen boilers, with an aggregate evaporative capacity of 9,100,000 lb./hr. of steam were installed in sixteen power stations, belonging to the C.E.G.B. in England and Wales, two of which were new stations. Four of the seventeen new boilers, having an aggregate capacity of 2,190,000 lb./hr. of steam, were oil-fired. At seven existing stations, a further twenty-eight boilers, with an aggregate evaporative capacity of 11,200,000 lb./hr. of steam, were converted from coal to oil firing. Of the generating units, the first of a number of 120-MW units (installed capacity) planned for commissioning in the next few years was, as mentioned above, brought into service at Blyth "A" power station on the north-east coast. This is the largest unit yet installed by the Board. The boiler associated with this unit has an evaporative capacity of 860,000 lb./hr. of steam and supplies steam for the turbine at a pressure of 1,500 lb./sq. in. and a temperature of 1,000 deg./1,000 deg. F. In the accompanying table, Blyth "A" and Bold "B" are the two power stations in which the first commissioning of plant took place in 1958. The others are existing stations to which extensions have been made.



HUNTERSTON—(*Left*). *View from the top of Goliath crane showing in the background, the first reactor building, in the foreground the second reactor building, and on the right work in progress on the turbine hall.*

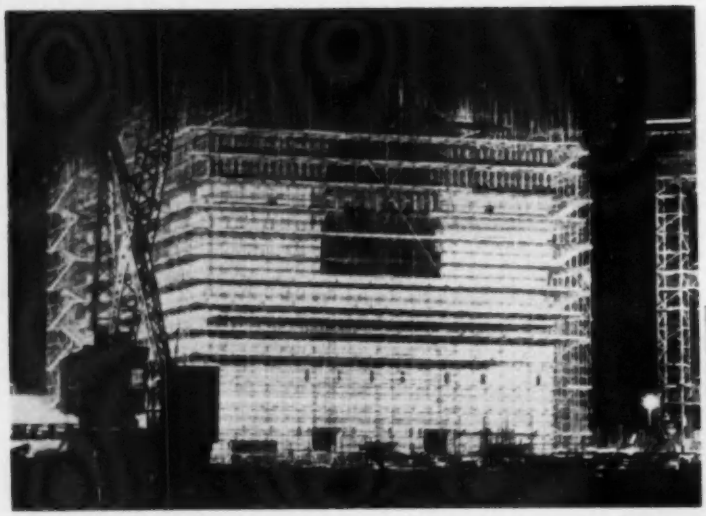
(*Below*). *The Goliath crane straddling the first reactor building at Hunterston.*

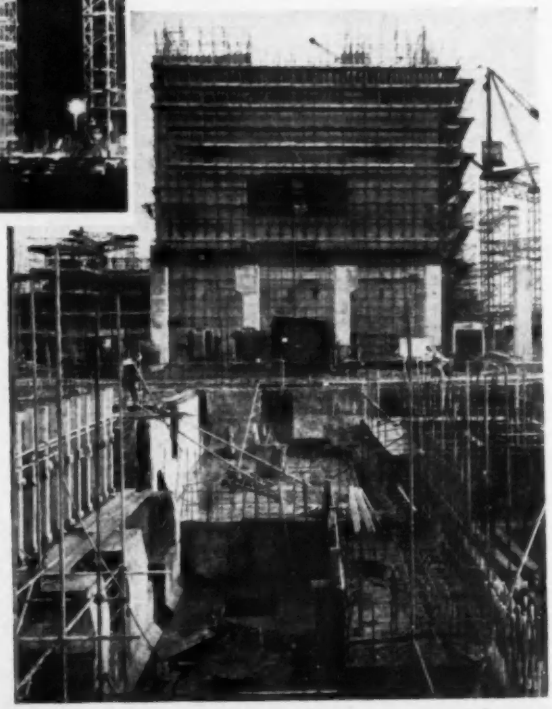


Nuclear power progress

The construction of the three nuclear power stations in England at Bradwell, Berkeley and Hinkley Point, and the one in Scotland at Hunterston has progressed steadily No other new station construction has been commenced during the year; but preliminary site clearance work and levelling has started at Trawsfynydd in North Wales, and the Central Electricity Generating Board have announced that they wish to construct nuclear power stations at Dungeness in Kent, and at Sizewell on the Suffolk coast. The Dungeness station is likely to have an installed generating capacity of 500-550-MW, while the proposed Suffolk station will be of about 650-MW. All these stations are, of course, being designed for base-load operation.

In a paper presented to the tenth British Electrical Power Convention at Brighton, in June last year, Sir Christopher Hinton, chairman of the C.E.G.B., pointed out that the large expansion of the power plant programme, which was adopted in 1957, brought with it another major problem. He stated that "the cost of electricity produced in nuclear power stations has been based on the assumption that these power stations will work as base-load stations with an annual load factor of 75 per cent. To use nuclear power stations in such a way is obviously wise because of their high capital cost, but it is a privilege which they cannot enjoy indefinitely unless system load factors are considerably increased by, for example, three-shift working in industry." He pointed out that "at present the load factor on the British electricity system is under 50 per cent., and the minimum continuous load is only about 3,000-MW. This occurs at night, during week-ends in the summer, and is in



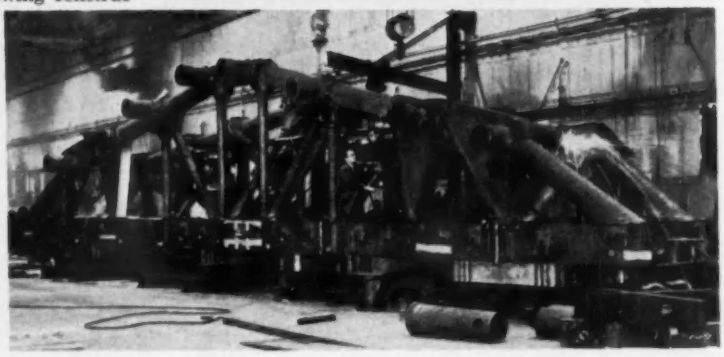


HINKLEY POINT—(Left). *View showing progress to date on the construction of No. 1 reactor building. Floodlights are used during the hours of darkness to enable the work to proceed without interruption. (Below). Close-up showing foundations for No. 2 reactor, with No. 1 reactor building in the background.*

effect the base-load of the system." Sir Christopher then went on to explain to his audience that in these circumstances it is imperative that the capital cost per megawatt is reduced and that such a reduction is achieved by 1966 because, by that date, the C.E.G.B. would be ordering stations that required to operate at lower load factors.

Responsibility for the development of new types of nuclear reactor, rests with the Atomic Energy Authority, and it is interesting to note that they have announced that work has already started on what is called the Advanced Gas-Cooled Reactor. This reactor is to be built at the authority's Windscale works. It is a further, and a logical, development of the gas-cooled graphite-moderated system on which the present nuclear power stations are based. The reactor is due to start up in 1961 and on the experience gained in the design, construction and operation of this reactor, the design of advanced nuclear power stations will be based.

The illustrations accompanying these notes are views taken within the past few weeks and showing construction progress made on the first three nuclear power stations to be ordered expressly for generating electricity for the public supply system in Great Britain. The reactors for all these stations are to be of the graphite-moderated, gas-cooled type. The station at Bradwell, which is being built by the Nuclear Power Plant Company Ltd., will have an output of 300-MW from two reactors, each of which will be associated with six steam-raising units. These latter are being constructed by Clarke, Chapman & Co. Ltd., a member company of the Nuclear Power Plant Company. One of our illustrations shows three of the steam-raising units erected in position. The dual-pressure steam will be generated at 755 lb./sq. in. and 195 lb./sq. in., at 704 deg. F. The concrete biological shield which is 8-ft. 6-in. thick is almost complete, while work on the No. 2 reactor is proceeding according to schedule, and the turbine house is almost complete.



Prefabrication of the trusses of the Diagrid for the core of Hinkley No. 1 reactor, being carried out at the Renfrew works of Babcock & Wilcox Ltd.

Berkeley nuclear station, being constructed by the

A.E.I.-John Thompson Nuclear Energy Company Ltd., will have a net output of 275-MW, from two reactors which will supply heat to eight steam-raising units operating on a dual pressure cycle at 306 lb./sq. in. and 62 lb./sq. in.—the final steam temperature in each case being 612 deg. F. The electrical output will be generated by four hydrogen-cooled turbo-alternators each of 80-MW rating. The station, like that at Bradwell, is due to be on full commercial load during the winter of 1960/61.

The station at Hunterston, Ayrshire, being constructed by the G.E.C.-Simon Carves Atomic Energy Group, for the South of Scotland Electricity Board, will have an installed generating capacity of 360-MW from six 60-MW hydrogen-cooled turbo-alternators which will give a net output of 300-MW, rising 320-MW.

Hunterston will differ in detail from the other stations in that the pressure-vessel enclosing each reactor will be of double shell construction, with an inner shell of temperature resistant steel and an outer spherical shell (3 in. thick by 70 ft. diam.) to contain the pressure. Fuel element changing will be carried out from below with the reactor on load. Carbon dioxide will be circulated through each reactor and the six associated steam raising units at a pressure of 150-lb./sq. in., the gas temperatures being 293 deg. F. at the reactor inlet and 752 deg. F. at the reactor outlet. Steam will be generated at two pressures, 585 lb./sq. in. (700 deg. F.) and 155 lb./sq. in. (670 deg. F.).

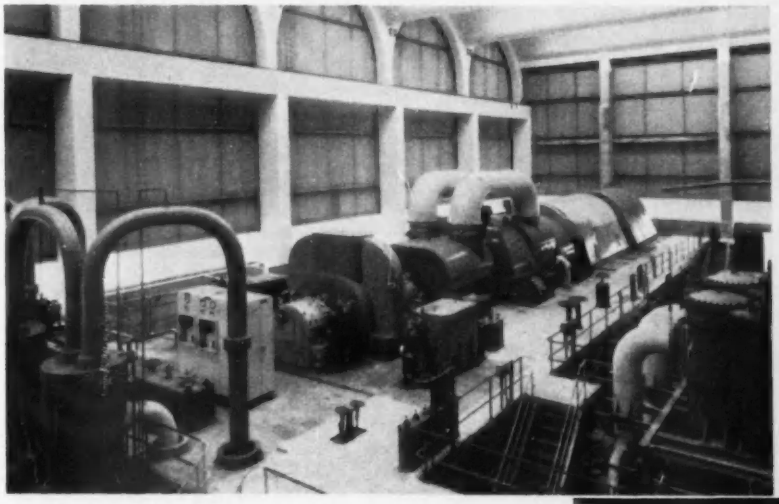
Hinkley Point, being constructed by The English Electric-Babcock & Wilcox-Taylor Woodrow Atomic Power Group is the fourth and latest station to be ordered under the British nuclear power programme. It is thought to be the largest nuclear power installation being built anywhere in the world. When the station is completed in 1962, the two reactors will be associated with twelve steam-raising units providing a total steam production capacity of 52 million lb./hr., which will be supplied to six main turbo-alternators, and to have variable-speed turbo-alternators which will supply power for driving the gas-circulator blowers. The gross equivalent electrical output from the two reactors will be 660-MW; but of this amount, 160-MW will be required for driving the auxiliary plant within the station.

The reactor spherical pressure-vessels which are being constructed by Babcock & Wilcox Ltd., are of a boiler quality mild-steel suitable for site fabrication, and relatively immune to radiation damage. By a combination of internal insulation of the top of the vessels, external insulation of the bottom of the vessels, and carefully designed air-cooling arrangements, it will be possible to maintain the vessel temperature between 600 and 650 deg. F. The steam-raising units, also being made by Babcock & Wilcox Ltd., are of the same general type which the company constructed for Calder Hall, but are of much improved design, with a volumetric heat rating about twice that achieved at Calder. Each unit will be capable of handling more than 160-MW of heat, as compared to about 50-MW each at Calder.

Manufacturers' progress

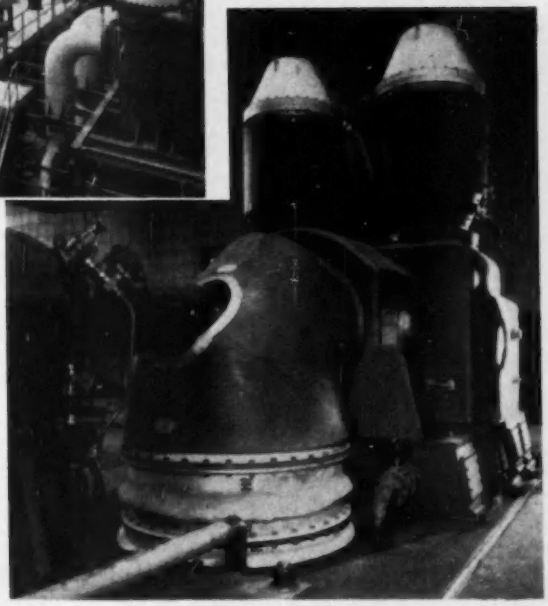
THE ENGLISH ELECTRIC CO. LTD.

Among the many orders for steam turbo-alternator sets received during the year by The English Electric Co. Ltd. was that for the two 275-MW units for the Blyth "B" power station of the Central Electricity Generating Board. This contract represents the first single-line

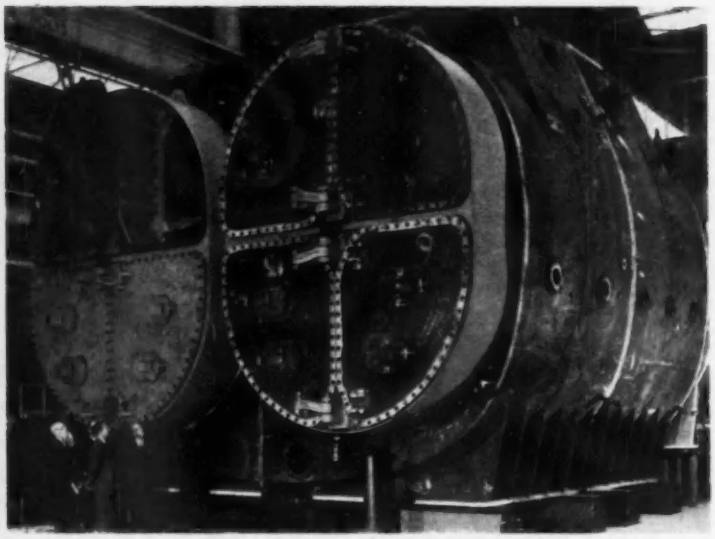


(Left). The second of four English Electric 100-MW turbo-alternator sets at Willington "A" power station. This is the first machine in Great Britain with hydrogen-cooled rotor and stator windings.

(Below). An English Electric 2,250-kW gas-turbine-driven generating set installed at the Ashford Common pumping station of the Metropolitan Water Board.



tandem units of this size to be manufactured in Europe. These machines will run at 3,000 r.p.m. and operate with steam conditions of 2,300 lb./sq. in. and 1,050 deg. F., with reheat to 1,050 deg. F., and exhaust to 29.0 in. Hg. The alternators will be of the direct hydrogen-cooled type with a rated gas pressure of 45 lb./sq. in., and generating at 16,000 volts. Another order of considerable interest is the contract associated with the United Kingdom Atomic Energy Authority's new advanced gas-cooled reactor, comprising a 33-MW steam turbo-alternator set, condensing and feed-heating plants, together with auxiliary apparatus. Scheduled to come into operation during 1961, the new reactor will contribute to the U.K.A.E.A. programme for realising the maximum development potential of the gas-cooled, graphite-moderated reactor. The turbine is a two-cylinder 3,000 r.p.m. machine operating with steam conditions of 650 lb./sq. in. and 850 deg. F. and exhausting at 28.6 in. Hg. Repeat orders for the home market received during the year included a seventh 6,500-kW set for the West Hartlepool Works of the South Durham Steel & Iron Co. Ltd.



(Left). Machining a solid-type steam inlet nozzle for an English Electric 275-MW steam turbine. (Right). One of five 200-MW twin-condensers for High Marnham power station, shown erected at the Rugby works of The English Electric Co. Ltd.

Among export orders received, the 100-MW set for the Thunder Bay power station of the Hydro-electric Power Commission of Ontario is a three-cylinder, 3,600 r.p.m. machine, operating with steam conditions of 1,450 lb./sq. in., and 1,000 deg. F., and exhausting to a vacuum of 29.0 in. Hg. A repeat order for the overseas market was a third 10-MW, single-cylinder machine for Malaya.

During the year, the sixth 60-MW set for Marchwood and the second 100-MW turbo-alternator at Willington "A" station for the C.E.G.B. were commissioned. This particular unit at Willington is of interest, in that the alternator has hydrogen-cooling of the rotor and stator through hollow conductors, being the first machine of this type to be made in this country. In the industrial field, three 6,500-kW units for the Cargo Fleet Iron Works of the South Durham Steel & Iron Co. Ltd. and a 5,000-kW set for Kodak Ltd. were put into commission. Overseas, the new extension to St. George's Bay power station of the Athens Piraeus Electricity Company comprising one 60-MW set and one 14.3-MW topping set, together with all boiler plant, ancillary plant, buildings, etc., has been completed. The twelfth 30-MW set was commissioned at Vierfontein, South Africa, thus completing this station for the Electricity Supply Commission. Much progress has been made on the comprehensive contract at the North Point "B" power station, Hong Kong, and the first 30-MW set has been put into commission. During 1958, the order for the second extension, i.e., No. 3 set, was received from the Hong Kong Electric Company whilst No. 2 set is in course of erection. Other sets put into operation overseas included the first 31.5-MW set for Abadan, the second 30-MW set for Umgeni, Natal, the first 30-MW set for Mercer, New Zealand, the first 10-MW set for Malacca and a 6,250-kW set for Bahrein.

As regards hydro-electric plant, the year has been notable for the amount of work in progress and completed. Amongst the water-turbine-driven generating sets commissioned is the second main set at Hirakud (India) rated at 37.5-MW, the second set at Hume (Australia) rated at 25-MW, and the plant in the Glenmoriston and Lochay power stations in Scotland, which contain two 18-MW and two 22.5-MW sets respectively. The delivery of the four 134,500 h.p. water turbines for Snowy T.1 in Australia, and of the first two 68,000 h.p. turbines for Table Rock in the U.S.A. has been completed. Other equipment delivered included the 50-MW hydro-electric set for Warragamba (Australia), the two 4,600-kW sets for Corner Brook (Newfoundland) and the two 2,500 kVA alternators for La Val (Mauritius). During the year, good progress has been made on the Hirfanli hydro-electric installation in Turkey, and all three machines have now been delivered to site, each unit having a capacity of 36-MW. The order for the plant for the Priest Rapids power station in U.S.A. was extended from eight 131,000 h.p. water turbines, coupled to 95,500-kVA alternators, to ten machines.

The "English Electric" EM27 gas-turbine has

continued in regular production through the year, and arrangements have now been made for batch production of a larger unit known as the EM85. This is an open-cycle, two-shaft turbine rated at 8,000 h.p. at 80 deg. F. ambient temperature and 14.7 lb./sq. in. absolute pressure. The nominal turbine inlet temperature is 790 deg. C., and the cycle pressure ratio just over 6 : 1. All stages of the compressor are axial, and only one combustion chamber is used. The compressor and output turbines are mechanically separate and have two axial stages each. The company is equipping multi-unit gas-turbine installations in generating stations at two overseas oilfields, the fuel being natural gas. Four EM85 gas-turbines, also arranged to burn natural gas, have been ordered by the Basrah Petroleum Company for the tanker loading facility that is to be constructed near Fao on the Persian Gulf. In July of this year, the Metropolitan Water Board's Ashford Common pumping station in Middlesex was officially opened, and here, an "English Electric" EM27P gas-turbo-alternator set is installed as part of the station's standby generating capacity. The unit is of interest since it is arranged for starting from a battery, the starting system being initiated by operating a single push-button.

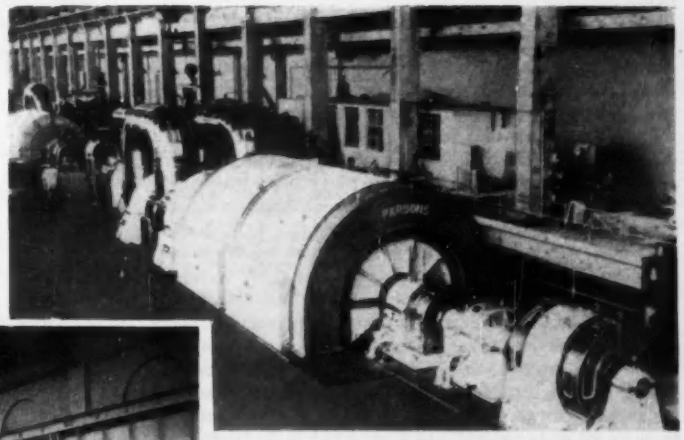
Nuclear power developments

The English Electric Co. Ltd. are, of course, associated with Babcock & Wilcox Ltd. and Taylor Woodrow Constructions Ltd., in the construction of the world's largest atomic power station of 500-MW capacity at Hinkley Point on the coast of Somerset, and expansion of the company's Atomic Power Division is reported to continue in order to meet not only the requirements of the Hinkley Point station but also the development and design of improved reactors. Facilities now include a large laboratory block for research into such aspects as atomic fuel canning materials which will contribute to more efficient stations. Another new building which will soon be in full operation is for the machining of graphite blocks and tiles for reactors of the graphite-moderated type. Further workshop and office buildings are under construction. While close attention is being paid to the home programme of nuclear power, much effort is being devoted to the export field.

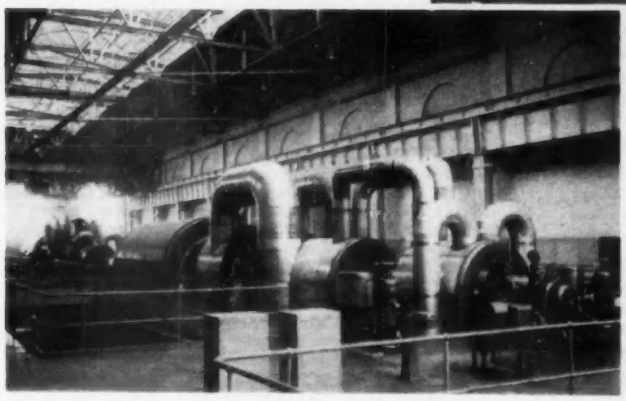
C. A. PARSONS & CO. LTD.

What is claimed will be the world's largest turbo-alternator—the 550-MW cross-compound machine for the Thorpe Marsh power station of the C.E.G.B.—was ordered during the year from C. A. Parsons & Co. Ltd. The machine will have eight turbines, all of the double-flow type, and two 275-MW hydrogen- and liquid-cooled generators. Both sections of the machine will run at a speed of 3,000 r.p.m. and will be arranged in line. Steam conditions at the turbine inlet will be 2,300 lb./sq. in. and 1,050 deg. F., with reheat to the initial temperature after the high-pressure turbine. The output from this machine will represent an increase of 250-MW over that of the largest machines previously ordered from the company by the Hydro Electric Power Commission of Ontario for the Lakeview generating station. These latter machines will be the largest machines to be exported from this country, and the largest to be installed in Canada. The steam conditions are 2,300 lb./sq. in. and 1,000 deg. F. with reheat to 1,000 deg. F. In addition to these large machines, orders have been received for turbo-alternators of 30-MW, 15-MW and 10-MW for installation in power stations in Australia, Canada,

(Right). The first of three C. A. Parsons & Co. Ltd. 60-MW turbo-alternators installed at Lake Macquarie power station, New South Wales, Australia.

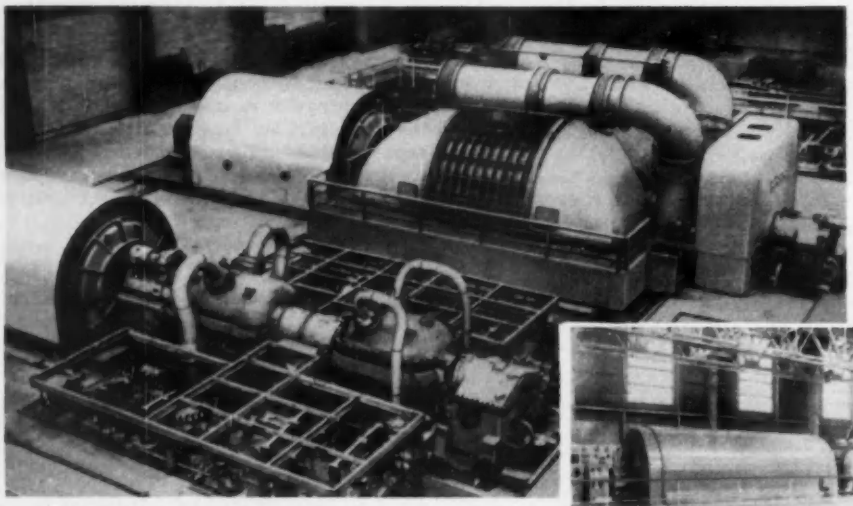


(Below). Two Parsons 60-MW turbo-alternator sets at the Dalmarnock power station of the South of Scotland Electricity Board.



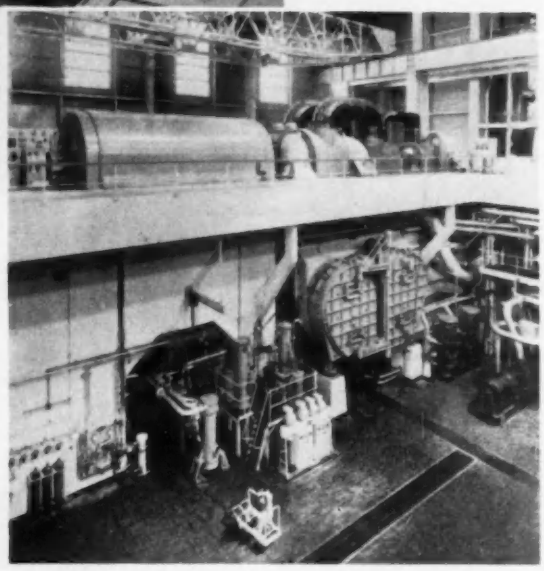
South Africa, Jamaica and Nigeria respectively.

Units installed during the year include 120-MW sets at Kincardine, and Drakelow "B" power stations, these machines being the first of fifteen of this size under construction at the company's Heaton works. Operating steam conditions are 1,500 lb./sq. in. and 1,000 deg. F., with reheat to the initial temperature. A second 100-MW machine has been commissioned at Ferrybridge "B" power station, while a third and similar machine, at present under erection



(Left). A Parsons 200-MW set nearing completion at the Richard L. Hearn power station, Toronto.

(Below). One of the three Parsons 60-MW turbo-alternator sets at Tilbury power station.



on site, will be completed early this year. During the year official opening ceremonies have taken place at three of the stations where Parsons have installed 60-MW machines; viz., Tilbury (three), Rogerstone (two), and Dalmarnock (two). A 60-MW set, (the third machine) has been commissioned at the Municipal Power Station, Belfast. Some interesting smaller sets ranging in size from 3.85-MW to 20-MW have also been commissioned in this country during the year. Two machines of 20-MW output have been completed at Grimethorpe for the National Coal Board, and this station now contains three Parsons sets of this size.

The first of four 200-MW turbo-generators on order for the Hydro-Electric Power Commission of Ontario for the Richard L. Hearn generating station was completed during the year and despatched to site. The set is of the cross-compound type designed to operate with steam conditions of 1,800 lb./sq. in. at 1,000 deg. F., with reheating after the high-pressure turbine to 1,000 deg. F. Parsons are also installing a two-cylinder 66-MW turbo-alternator at Boundry Dam, Saskatchewan, the first of two machines for this station. Two further machines of the same output are on order for Winnipeg, Manitoba. In Australia, the first of three 60-MW turbo-alternator sets has been installed in the Lake Macquarie power station. This is the largest machine operating in Australia, and the first in that country to be equipped with a hydrogen-cooled generator. In the Tennyson power station, Brisbane, two further 30-MW machines have been commissioned. Other turbo-alternator sets with outputs between 4-MW and 20-MW have been commissioned in India, Canada, Iraq, Jamaica and South Africa.

Nuclear power plant development

During the year an order was received from The Nuclear Power Plant Co. Ltd. for three 70-MW turbo-alternator sets to be installed in the nuclear power station to be constructed at Latina, Italy. These machines will be of the two-cylinder type with three exhausts, and will operate with steam conditions of 730 lb./sq. in. and 700 deg. F. In this country, at Calder Hall "A" and "B" stations all eight 23-MW capacity machines have now been installed, and two similar sets installed in the Chapelcross station. Progress continues at the Heaton Works on the contract for Bradwell nuclear power station, which includes six 52-MW turbo-alternators, three 20.25-MW auxiliary machines and all the condensing plant, main gas-circulators, ductwork and valves, etc.

NEW LOCKHEED COMPANY

In furtherence of a policy of decentralisation and expansion, **Automotive Products Associated Limited** have formed a new company, known as **Lockheed Precision Products Limited.** The company, with design and manufacturing facilities already available at the group's factory at Speke, Liverpool, will manufacture and sell the products of the Industrial Hydraulics, Aircraft Hydraulics and Avery Hose & Coupling Divisions. Lockheed centralised hydraulic controls have, for a good many years, been widely used for the control of boiler dampers, valves, filtration plants, power station and factory windows, etc. Such equipment is installed in many of the large power stations and industrial plants in this country, and in many other parts of the world, in which the operation of a number of distant mechanisms from a central control panel is usually a desirable, and often a necessary, requirement. These controls can be manual-hydraulic or power-hydraulic—the latter with or without manual-hydraulic control as an immediately-available stand-by. One of the outstanding merits of these Lockheed controls is that the very minimum of maintenance is needed because oil-hydraulic controls are self-lubricating.

Cyclohexylamine in Water Treatment

By W. K. Ashcroft, M.A. (Cantab.)* and P. N. Heron, M.A. (Cantab.)†

THE discovery that water obtained from marshes and bogs was less scale-forming than water from other sources, in spite of the obvious impurities indicated by its colour, was probably accidental, and possibly the first reference to deliberate water treatment appeared in 1823 when the use of potatoes was advocated to prevent scale[1]. The engineer of the time went a step further when he experimented with sawdust, bark, potato peelings and linseed to prolong the life of his equipment and to improve the efficiency of steam raising, and later still the chemist took an active part in solving the problem, and began to extract the active ingredients—tannins from bark, alginates from seaweed, and starch from potatoes. Eventually, chemicals having no obvious connections with the early treatments were tried because they had a chemical composition which suggested that they would perform a particular function. The technique of water treatment had by then become a science.

Available literature on the subject of water-treatment is very comprehensive, and deals with both inorganic and organic chemicals. In the present article the published information on only a small section—the treatment of boiler feedwater by cyclohexylamine to prevent corrosion by dissolved carbon dioxide—is reviewed.

The problem of corrosion

The two major causes of corrosion of iron and steel in steam power plants are dissolved oxygen and dissolved carbon dioxide. In 1942 Skaperada and Uhlig[2] summarised the problem as essentially a corrosion reaction between carbonic acid and iron with ferrous bicarbonate and ferrous hydroxide as the reaction products. Even without oxygen, carbon dioxide causes corrosion, but in the presence of oxygen the reaction is more rapid because in addition to oxidising ferrous compounds to the less soluble ferric compounds which are removed, the oxygen reacts with atoms of liberated hydrogen and prevents the formation of a protective layer of gas on the metal surface. Low concentrations of carbon dioxide, for example, 2 ppm, in a system with a large flow, can cause serious corrosion. Similar considerations apply for other metals such as copper.

Removal of carbon dioxide

The elimination of dissolved carbon dioxide by mechanical methods only, is not entirely successful because it is less easy to remove than oxygen. As regards chemical methods, although caustic soda has long been used to maintain sufficient alkalinity in boiler water to protect the evaporative surfaces of the boiler against corrosion by carbonic acid, it offers no protection to other parts of the system in contact with steam or condensate. The first reference to the possibility of protecting all parts of a steam-raising system appears to have been made by Speller[3], who suggested that "a suitable volatile alkaline compound should be useful, when added to the boiler, to neutralise any acidity in the steam." Dreyfus[4] was granted a patent in the U.S.A. in 1936 on the use of substituted ammonia compounds for this purpose, but it was many years before this method was developed for large-scale use. Attempts to utilise blowdowns from the boiler system by bleeding them into the steam distribution system were partially successful, but tended to cause blockages in piping and other equipment[5].

Chemical treatment

Essential properties required of chemicals used for the treatment of boiler feed-water are solubility in water, and sufficient inherent alkalinity to react with carbon dioxide to form salts. The compounds must vaporise and condense with steam so that they are effective throughout the entire vapour and condensate zones. Other requirements are that they should have no harmful effect on metals, be stable at the concentrations used for boiler feedwater treatment without decomposition to ammonia, must not interfere with conductivity instruments used for detecting condenser leakage, and be capable of raising and controlling the pH of the condensate by dosage adjustment. Cyclohexylamine, which is one of the volatile amines meeting these requirements, has the following properties:

Formula	$C_6H_{11}NH_2$	
Molecular weight	99	
Specific gravity (15.5 deg. C.)	0.870-0.873	B.S. 2534 : 1955
Distillation range (95 per cent.) at 760 mm.	129-138 deg. C.	B.S. 2534 : 1955
Amine content	Greater than 99 per cent.	B.S. 2534 : 1955
Dissociation constant at 25 deg. C.	1.58×10^{-4}	
pH of 100 ppm solution in water	10.5	
pH of dilute solution of amine carbonate	8.1	

Cyclohexylamine is a clear, practically colourless liquid, with a characteristic odour of ammonia, and miscible with water and most organic solvents. It distils without decomposition, and forms a constant boiling mixture with water distilling at 96.4 deg. C. under 760 mm. pressure and containing 44.2 per cent. cyclohexylamine.

It is suggested that sufficient cyclohexylamine should be introduced to maintain the pH of the condensate at about 8.5[6,7], preferably applied continuously[5,12] rather than in shock doses, after an initial treatment to adjust the pH to 8.5. Exact quantities required must depend upon the quantity of water in any particular system, make-up, and carbon dioxide concentration. The sampling point should be typical of the return system and contain no make-up or boiler water.

Losses from the system occur at steam vents, leaking connections and de-aerators, but there are virtually

*Monsanto Chemicals Limited.
†Printing, Packaging and Allied Trades Research Association, and formerly of Monsanto Chemicals Limited.

no losses in blowdown[9,10]. Steam losses should be reduced to a minimum and the de-aerators operated at the highest possible temperature[12]. Although cyclohexylamine retains some carbon dioxide as the carbonate, this is removed by the stronger base, caustic soda, when the water returns to the boiler, and the cyclohexylamine re-circulates again[6].

When using ammonia for pH control in Germany during the last war it was found that corrosive attack on copper and copper alloys could occur particularly in the presence of oxygen, and leaks created a hazard[13,14]. The possibility of ammonia formation by the decomposition of cyclohexylamine was, therefore, seriously considered, but service records show that the risk is negligible[9,7,10,15,16].

Analytical determination of cyclohexylamine is, of course, important, and good approximate results can be obtained by direct titration of uncontaminated condensate with standard hydrochloric acid using an indicator containing 0.04 per cent. of methyl red and 0.02 per cent. methylene blue which changes from grey to pink at pH 4.9. However, if another source of alkalinity is present the amine must first be separated by volatilisation from an alkaline solution [12,17]. Low concentrations (6-20 ppm) are best determined by comparing with a standard the turbidity produced in 50 ml. by 1 ml. of Nessler reagent[18].

A recent development is the use of cyclohexylamine carbonate in the protection of the fire side of boilers when the units are not in service. The Chemical Research Laboratory of the Department of Scientific and Industrial Research has reported that it has shown promise in this application, and further experiments are in progress.

Tests with cyclohexylamine on boiler plants

Cyclohexylamine has been extensively used, particularly in the United States, and the following information has been obtained from published accounts of its application in that country. Ristroph and Powell[7] carried out tests on the contamination of condensate by heat-exchanger-tube alloys at the Bremo power station, and at the same time the influence of cyclohexylamine on the rates of contamination was investigated. One unit on which the tests were carried out was of 625,000 lb./hr. capacity with steam conditions of 1,385 lb./sq. in. and 950 deg. F. Blowdown was approximately ½ per cent. of the boiler feed. Under normal operating conditions the carbon dioxide concentration was low (less than 1 ppm), but some contamination of condensate from the various alloys still occurred. The chemicals normally used for water conditioning at the time of the tests were sodium hydroxide, sodium metaphosphate and sodium sulphite. For the cyclohexylamine tests which began on November 7th, 1951, the amount of caustic soda was decreased and fed directly with the phosphate into the boiler drum. To maintain the pH at 8.5, cyclohexylamine was added at approximately 75 ml./day with a steam-generating rate of 12,600,000 lb./day. Analyses for iron content of the water before the test commenced, and again some weeks after the start of the cyclohexylamine treatment showed a distinct reduction in contamination. Thus, whereas the condensate at the hot-well contained 0.22 ppm Fe before treatment with cyclohexylamine, afterwards it contained only 0.07 ppm. Corresponding figures for iron content of the feedwater entering the economiser showed a drop from 0.16 to 0.08 ppm Fe. The cyclohexylamine treatment also effected a marked decrease in rates of contamination imparted by all non-ferrous alloys tested, and prevented entirely iron contamination from type 316 stainless steel. The response of nickel-bearing non-ferrous alloys was, however, less marked than those of other alloys. The only occasion on which ammonia was detected was when operating at pH 9. When the pH was lowered to 8.8 the ammonia concentration was reduced from 0.2 ppm-0.05 ppm. No increase in the copper content of the feedwater was noticed during the brief period when the ammonia concentration was high. In addition to the lower rates of metal contamination, a definite improvement in operating efficiency was noted as a result of cyclohexylamine treatment. Thus, a fall from 240 amps to 180 amps in motor input was observed without mechanical cleaning, and significant improvements in flowmeter indications and attemperator performance were noted. The feed pumps apparently became self-cleaning whereas previously it was necessary to remove accumulating deposits by manual cleaning with caustic soda.

At the Mitchell power station three boilers, each of 500,000 lb./hr. capacity, and steam conditions of 1,400 lb./hr. and 925 deg. F., were used in the trials reported[8]. Following addition of cyclohexylamine to the feedwater system to increase the pH to 8.6, the already low concentration of copper in the feedwater remained substantially the same at 0.01 per cent., but the iron content of the condensate was reduced from 0.12 to 0.03 ppm Fe during treatment over a four-month period.

The trials reported by Jensen and Lang[15] were carried out on boilers rated at 420,000 lb./hr., operating at 450 lb./sq. in. and 750 deg. F. at the Long Beach power station. In the first series of tests undertaken cyclohexylamine was added to the system whenever the pH dropped to 8.0 in order to raise it to the normal figure of 8.5. Analyses carried out on the condensate 60 days after the treatment was commenced showed significant reductions in the iron and copper content. It was further shown that continuous feeding of cyclohexylamine at 3.6 ml. per million lb. of feedwater, to maintain a more uniform treatment by means of a proportioning chemical feed pump, reduced iron and copper pick-up still further. The most favourable results were obtained by a continuous feed of sodium sulphite in addition to the cyclohexylamine, the former acting as an oxygen scavenger. The results obtained are summarised in Table I:—

TABLE I

	Unit No. 10		Unit No. 11	
Analysis of condensate-pump discharge	Cu ppm	Fe ppm	Cu ppm	Fe ppm
Sodium sulphite only slug-fed to boilers once a day	0.019	0.17	0.026	0.20
Sodium sulphite + cyclohexylamine both slug-fed to boilers once a day	0.021	0.08	0.015	0.11
Sodium sulphite + cyclohexylamine fed continuously to condensate-pump discharge	0.009	0.02	0.009	0.02

At the Redondo thermal generating station[15], which has an installed capacity of 300-MW, operating with steam conditions of 850 lb./sq. in. and 900 deg. F., caustic soda and sodium sulphite had originally been used for water treatment. Iron content in the feedwater was 0.08 ppm Fe. Cyclohexylamine was added

to the caustic-sulphite tank, the pH of the condensate after the point of caustic feed being maintained at 8.5. Iron content was reduced to 0.02 ppm Fe, a reduction of 75 per cent., and copper was reduced approximately 50 per cent., from 0.019 to 0.010 ppm Cu. The use of cyclohexylamine made it possible to reduce the caustic feed by 25 per cent. with consequent reduction in blow-down. Boiler deposits were reduced considerably. Approximately 3 ml. of cyclohexylamine per million lb. of feedwater was needed to maintain the desired quality and no increase in ammonia concentration was noted beyond the 0.01 ppm originally present.

Trials reported by Ristroph and Yorkgitis[10] were carried out at the Chesterfield power station on two boiler units operating at a pressure of 900 lb./sq. in. and a temperature of 900 deg. F., and on one controlled circulation unit operating at 1,500 lb./sq. in. with initial and reheat steam temperatures of 1,000 deg. F. It was shown that cyclohexylamine used for condensate pH control was successful in keeping iron and copper pick-up at a minimum. Perhaps the main point of interest which emerged from these tests was that although the concentration of iron and copper in the condensate was quite low when the pH of the latter was held at 8.5-8.7, an even further reduction was effected by increasing the pH to 8.9-9.1, as shown in Table II:—

TABLE II

Sample from:	Hot Well		Inlet 17th Stage Heater		Inlet Deaerator		Inlet Economiser	
pH at hot well ...	8.5-8.7	8.9-9.1	8.5-8.7	8.9-9.1	8.5-8.7	8.9-9.1	8.5-8.7	8.9-9.1
Total Fe ppm ...	0.006	0.004	0.045	0.026	0.090	0.033	0.006	0.004
Total Cu ppm ...	0.006	0.005	0.049	0.041	0.019	0.006	0.007	0.004

These results, however, would appear to be specific for the plant concerned, for it is reported[11] that one of the Southern California Edison plants gained nothing by increasing the pH of the condensate above 8.5. Further, no appreciable change was reported in copper or iron pick-up over the pH range of 8.7-9.1. It would appear that in the majority of cases a pH of 8.5-8.7 is the optimum value for obtaining the most economical results.

Crater[19] reports that cyclohexylamine when used in a 40-MW steam power plant operating at 240 deg. F. was satisfactory in avoiding shut-downs by reducing corrosion and in increasing efficiency of operation by eliminating insulating deposits. Originally, doses of cyclohexylamine were added when pH tests on samples of the condensate with phenolphthalein indicated this to be necessary. It was subsequently found, however, that more consistent results were obtained by recording the pH value electrically and adjusting it continuously with automatic equipment.

Moncrief and Dreyfus report[20] on the results of continuous operation with cyclohexylamine over a period of thirty-three months, on a 49-MW steam power plant. An initial charge of 4 ppm of cyclohexylamine was introduced near the bottom of one of the condenser hot-wells over a period of 1 hr. to give a pH at equilibrium of 8.8 which dropped to 7.8 after several days. The desired pH range of 7.4-8.0 was obtained by carrying 1.5-2.5 ppm cyclohexylamine in the system and maintained by the addition of 1 ppm once a week. Since total evaporation averages 15,200,000 lb. per day with an average daily make-up of 77,400-lb. the regular cyclohexylamine addition to the system was slightly more than 1 ppm on make-up. During the use of cyclohexylamine a general increase in efficiency of the plant was noted. No replacements in the boiler feed pumps were necessary, although from previous experience without the use of cyclohexylamine it would have been expected that some replacements would have been required. The high-pressure heater operated longer than ever before without excessive loss in heat transfer and showed no deposit of iron oxide in the heater itself or in the surge tank. Corrosion of de-aerating and heating trays was much reduced since these continued in service although at the previous rate of deterioration new parts should have been necessary.

Other water treatment applications[16]

High-pressure hot-water systems, whether filled with raw water or water treated by the base-exchange or demineralisation process, must be conditioned to raise the pH value to 10-11, and for oxygen absorption. Caustic soda with tannins or sodium sulphite are the usual conditioning materials. Cyclohexylamine may be employed, however, for pH adjustment instead of caustic soda, sufficient being added to raise the pH value to 9.2-9.4. In this way deterioration of gun-metal and brass valves by dezincification can be avoided. Cyclohexylamine combined with tannins provides a complete treatment for this type of installation. Similarly, in low-pressure hot-water systems where there is a possibility of attack of non-ferrous fittings by caustic soda, cyclohexylamine provides a safe alternative.

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Progress in Stainless and Heat-Resisting Steels

By J. LOMAS

DURING the past year, steady progress has been made in the development of stainless and heat-resisting steels, and although much of the work in this latter category has been directed towards the field of rocket and missile research, the advances made will undoubtedly lead to improvements in these materials, as used by industry generally.

In the industrial field, and with particular reference to steam-raising plant, long-period creep and rupture tests on austenitic 18-12-1 chromium nickel niobium pipe and tube steels have shown the high creep-resistance of this material, but it may be difficult to take full advantage of this because of a tendency to rupture, with low ductility at high-stresses and temperatures. Suggestions for overcoming this problem are, however, the subject of further experimental work.

Tests have been carried out to determine the resistance of an aluminium nickel alloy, containing 1 per cent. nickel, to corrosion by high-temperature water, under conditions of irradiation. It has been found that the weight loss per unit is the same for both irradiated and non-irradiated metals. The non-irradiated metals had, however, a higher initial corrosion rate, and it is suggested that the usefulness of the 1 per cent. nickel-aluminium alloy would be improved by modification to combine a higher degree of mechanical strength with its proved corrosion-resisting properties.

A new age-hardenable nickel chromium stainless steel has been developed in the form of sheet and strip suitable for drawing and forming operations. The composition of the material is as follows:—carbon 0.08 per cent. max., silicon 0.5 per cent. max., manganese 1.0 per cent. max., chromium 14 to 17 per cent., nickel (including cobalt) 70 per cent. min., niobium (including tantalum) 0.7 to 1.20 per cent., titanium 2.25 to 2.75 per cent., aluminium 0.4 to 1.0 per cent., copper 0.5 per cent. max., iron 5 to 9 per cent. After age-hardening at between 705 and 710 deg. C. for 20 hr. and air-cooling, the material has an ultimate tensile strength of 69 tons/sq. in.; yield strength at 0.2 per cent. offset, 44.5 tons/sq. in.; and elongation 2 in. of 20 per cent. min.

The commercial exploitation of powder metallurgy for the production of steels is restricted by economic and technical difficulties. The technical difficulties have been particularly acute in the production of stainless steels, owing mainly to the inherent properties of the metals essential in such materials. The powder metallurgy method for the manufacture of stainless steel components is, therefore, still in a comparatively experimental stage. Considerable study is now being devoted to the improvement of pressing and sintering techniques, so as to obtain density and other mechanical properties equal to those of typical wrought and cast materials of comparable compositions. At the present time, it has only been possible to obtain practically useful properties in powder-produced components by a double-press-and-sinter technique using high-pressures and elevated temperatures. Progress is being made, however, in the production of strong ductile steels by a single pressing and sintering operation at temperatures of about 1,200 deg. C. In this connection it is worthy of mention that metallic filter components, made by sintering metal powder of controlled particle size to obtain the desired porosity and pore dimensions, have been developed for service under pressure and temperature conditions too severe to permit the use of more conventional filter media. In most instances the metallic filters are chosen also with particular reference to their corrosion-resisting properties.

A welded form of stainless steel tubing has been introduced primarily for such applications as high-pressure air ducting, in which it is necessary to have corrosion- and heat-resistance properties, especially where the ducting is welded during fabrication and the wall thickness is about 2 per cent. or less of the outside diameter. The steel contains 0.08 per cent. carbon, 0.5 to 1.0 per cent. silicon, 2.0 per cent. max. magnanese, 17 to 19 per cent. chromium, 9 to 12 per cent. nickel, niobium including tantalum 10 × C-1.10, 0.5 per cent. max. molybdenum, 0.5 per cent. max. copper.

With the higher pressures and temperatures achieved in modern boiler plants, austenitic stainless steels are being increasingly used for superheater sections. Ordinary 18-8 chromium nickel steels are not always suitable for this purpose, as they have to be used in tubes, the wall thicknesses of which make them uneconomic in both fabrication and use. For this reason a new steel has been developed which is said to possess good strength and corrosion-resistance at temperatures above 1,350 deg. F. and at pressures substantially in excess of 2,000 lb./sq. in. The minimum use of strategically important elements is involved in the manufacture of the new steel which has adequate heat- and corrosion-resistance, and properties which allow hot workability and weldability, together with freedom from embrittlement at elevated temperatures. The composition limits are: chromium 14 to 20 per cent., nickel 12 to 18 per cent., carbon 0.02 to 0.15 per cent., manganese 0.25 to 2.5 per cent., silicon 0.1 to 1.03 per cent., tantalum or tantalum and niobium 1 to 3.5 per cent., the balance being iron. Copper and/or molybdenum may also be present in amounts up to 3 per cent. each.

The resistance to corrosion by material used for the construction of coal bunkers, chutes and hoppers, is governed mainly by its ability to resist attack by ferric sulphate, the principal corrosive of steel encountered. Steels containing approximately 12 per cent. or more of chromium have been found, under test conditions to be ideal for such applications.

Tubes of ferritic steel can be joined to austenitic stainless steel tubes by an austenitic fusion welding alloy having an allowable working stress property greatly in

excess of that of the ferritic steel member at the service temperature of the welded part. The alloy must also have a coefficient of thermal expansion identical with, or substantially the same as, that of the ferritic member. The weld metal developed for this purpose is preferably an alloy containing at least 50 per cent. nickel and 10 per cent. chromium, the balance being iron.

Metallic surfaces are now being made heat- and corrosion-resistant by mixing small particles of aluminium, iron, nickel or cobalt with alumina, magnesium oxide or zirconium oxide, sintering the mixture, reducing, and flame-spraying the resultant substances on to the basis surface at a temperature of at least 1,150 deg. C.

In a boiler of the once-through type, the final stage heater of which increases the water temperature to 489 deg. F. using bleed steam at 700 deg. F., tube metal temperatures in the heater reach 600 deg. F. The large pressure drop between the final heater and the boiler demanded a design pressure on the tube side of the heater of 4,300 lb./sq. in. The most practical tubing material for these conditions was found to be Monel nickel copper alloy because it has the highest allowable design stress of any alloy suitable for this application, and so allows the thinnest tube wall for efficient heat transfer to be used. Tubes of 15 gauge thickness were used, made from rolled tube sheets. Some 456 U-shaped tubes were used and these included 85 ft. lengths, the longest ever drawn from this alloy.

A new form of operating controller employs permanent magnets to start a pump or cut off a burner. The magnets are fixed at the end of both float arm and switch contact arms, and the float is made of a strong, corrosion-resistant nickel copper corrosion-resistant material possessing the strength to hold up under high collapsing pressure as well as the resistance to the normal corrosive attack of high-temperature boiler water. The control can be adapted for use in installations operating in erosive steam pressures up to 250 lb./sq. in. and temperatures up to 400 deg. F.

It has been found that stainless steel surfaces lubricated with liquid sodium are capable, in the temperature range 100-200 deg. C., of supporting moderate loads without development of severe failure when used for pump bearings in power plant. Wear can occur to an appreciable extent, but because of the high thermal conductivity of the lubricant, local overheating and consequent seizure do not take place. Sodium, in respect of surface finish, lubricates in a reverse sense to mineral oil. The best lubrication is obtained on turned surfaces.

One example of the application of heat-resisting materials originally designed for a different application from boiler plant is found in an entirely new electrically-heated flash boiler and superheater with the high-temperature parts made of Nimonic 80 nickel chromium alloy. This alloy was originally developed for use in gas turbines, but is rapidly becoming a standard material for high-temperature engineering. The material was chosen because of its outstanding strength at high temperatures and excellent resistance to the corrosive attack of high-pressure steam. A further example of an extended application of this type is the use of Nimonic 75 alloy, also designed originally for gas turbine use, for the water pipes from the water-treatment plant to the feed pump, and from the feed pump to the boiler. The object here is to prevent galvanic corrosion of the boiler tubes and other components. No corrosion of these alloys has occurred during the operation of a laboratory installation, and the experience gained with this unit indicates a possible application in the more advanced types of steam power plant now being developed.

A further development comprises a stainless clad pipe having an internal surface of solid stainless steel permanently bonded to a heavier outer layer of carbon steel. This arrangement results in a pipe which is said to be less expensive than a solid stainless steel pipe, but has the same corrosion-resistant properties.

A new steel which, it is suggested, could be used in the manufacture of instruments and control equipment combines the high strength and relatively low thermal expansion of a 15-20 chromium 1-3 nickel steel of the corrosion-resistant type, with the corrosion-resisting properties of a standard 18-8 stainless steel. The new steel contains:—carbon 0.07 per cent., silicon 1.0 per cent. max., chromium 14-18 per cent., nickel 4-7 per cent., copper 1-3 per cent., molybdenum 1-3 per cent., titanium 0.5 per cent. max.

Pre-stressing of stainless steel tubes has been found to improve the fatigue life of formed tubing under repeated pressure pulsing, within certain limits. Pre-stressing, however, also produces distortion or permanent deformation, and it is, therefore, suggested that using a light clamp in pre-stressing, to restrain deformation to some extent, without appreciably sacrificing the gain in fatigue life, might be an acceptable compromise. For formed tubes designed for a given power transmission and required to survive 1,000,000 cycles of constant-pressure pulsing, a saving in weight of 12-35 per cent. can be achieved by pre-stressing, as long as the treatment is applied without rigid restraint and there is no later reworking, and also if the maximum pulsing pressure in service is not more than half the bursting pressure of the stainless steel tubing.

The use of stainless steel in the form of castings has been to some extent limited by the disadvantages sometimes found in cast materials, and as a result methods of producing complicated parts of high quality stainless steel have been improved. One such technique is vacuum degassing, which is showing promising results.

A stainless steel, claimed to possess superior resistance to intercrystalline corrosion and to transcrystalline stress-corrosion cracking combined with general corrosion-resistance superior to that of the hardenable 13 per cent. chromium steels, has been developed. It contains carbon 0.03 to 0.1 per cent., chromium 16 to 18 per cent., nickel 3 to 6 per cent., silicon up to 1 per cent., manganese up to 1 per cent., niobium and titanium in small amounts with iron as the balance. The steel has been used in service with caustic-contaminated water and steam with satisfactory results.

The welding of nickel chromium stainless steels used for high-temperature piping has been the cause of a certain amount of cracking in the welds, largely as a result of notches or sharp changes of section in the region of the joints; excessively high bending stress is caused by the movement of the piping systems, and absence of post-welding treatment of the joints. It is hoped that an improvement in this respect will be achieved, even after the above faults have been corrected, by the development of a 16-8-2 chromium-nickel-molybdenum-iron welding electrode.

RECENT Equipment AND Accessories

Flexibility in boiler panel design

For small boilers of the Economic, Lancashire and similar type, Electroflo Meters Co. Ltd. have made available a panel incorporating miniature instruments as shown in Fig. 1. Although a small panel, the instrument range is very comprehensive, including smoke density measuring and alarm equipment, two draught and temperature points, pressure indication with steam-flow integrators and recorders. Typical equipment, as shown, can, the company point out, be working on site within twelve weeks from receipt of the necessary technical information. The scheme can, of course, be modified or augmented to suit particular requirements and preferences if a specification is submitted. Fig. 2 shows a hypothetical panel for the control of two medium-sized boilers of the Economic, Lancashire or water-tube type. This panel, again using miniature instruments, provides four draught-pressure indications, six temperature indications, and steam-flow integration with recordings for each boiler. In addition, main steam pressure, flue gas temperature, CO_2 and smoke density are also metered. Facilities for remote control of auxiliary motors can also be incorporated, as shown, if such are required. This equipment could be working on site within 14 days of receipt of the required information, and here, again, the company can amend the design to conform with the particular requirements of the user. These two panels are representative of the complete range of boiler control panels which are provided by Electroflo Meters Co. Ltd., and installed all over the world for the control of plant varying from large high-temperature and pressure installations, such as power stations, to the smallest industrial plant. (*Electroflo Meters Co. Ltd., Abbey Road, Park Royal, London, N.W.*10.)

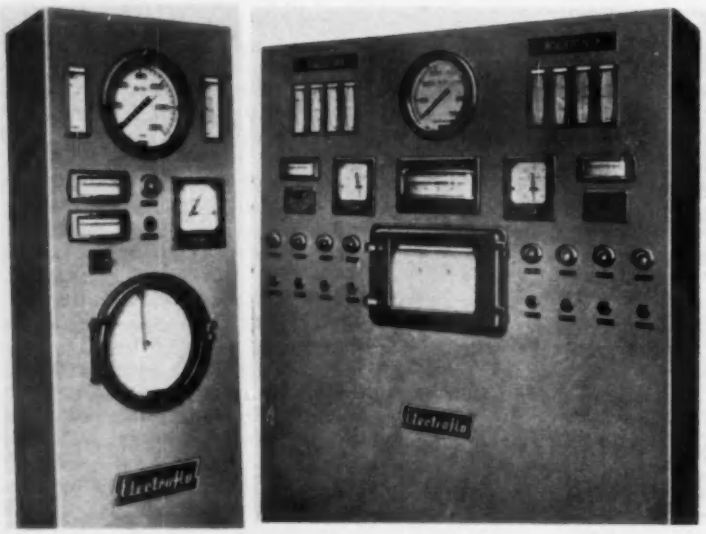


Fig. 1 (left). Control panel, incorporating miniature instruments, designed for small boilers. Fig. 2 (right). Panel for the control of two medium size boilers. (Electroflo Meters Co. Ltd.)

New centrifugal fan

Keith Blackman Ltd. announce a new centrifugal fan range to be known as the "Aristocrat," having high capacity and low sound level, for heating and ventilating, air-conditioning and general ventilation applications. The rigid casing embodying a new method of stiffening has a durable and high-quality light grey hammer-finish, and construction of the royal blue enamel impeller excludes the necessity of either centre spider or tie rods. The initial range will cover six sizes, Nos. 6, 9, 12, 15, 18 and 21—the No. 15 size (15-in. dia.) now being in production. The fans will be available for either direct motor drive or indirect drive. The indirect driven fan incorporates a common bearing housing to ensure accurate alignment, and is fitted with either double sealed ball bearings, without the need of introducing additional lubricant, or wick-lubricated sleeve bearings. The driving unit in each case is mounted on a steel pedestal. The fan casing embodies a large throat and outlet area, ensuring a low throat and outlet velocity, thus eliminating the necessity for external diffusers. The design of the curved inlet ensures streamlined airflow to the impeller obviating shock losses and eddy currents. The casing has a drilled flanged outlet and inlet for connection to ducting etc., or, for the attachment to the inlet of a protective guard. (*Keith Blackman Ltd., Mill Mead Road, London, N.*17.)

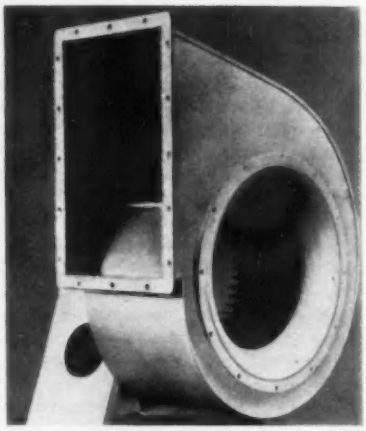


Fig. 3. A model from the new range of "Aristocrat" fans, viewed from the inlet side. (Keith Blackman Ltd.)

Vertical roller coal dryer

Neldco Processes Ltd., Ashford, Middlesex, who are to market, under licence, the Conreur vertical-roller coal-dryer in the United Kingdom, have recently completed an agreement with W. C. Holmes & Co. Ltd. for its manufacture and installation. The Conreur dryer, which has been manufactured in France by Conreur Ledent & Cie for the past ten years, is of sturdy construction and operates on the principle of counter-current drying by which hot gases travel in the opposite direction to the wet feed. The dryer consists of a steel tower, divided into sections and lined with

refractory brickwork. Each section is fitted with two cast-iron rollers, and driven at low speed from outside the dryer by a continuous sprocket chain. Power consumption is extremely low—a 25 ton/hr. dryer requires only 5 h.p. The interior of the tower is fitted with cast-iron baffles designed to direct the hot gases through the dryer with a minimum of resistance. A hopper at the top of the dryer discharges a thin ribbon of wet coal over the full width of the first roller. This discharges onto subsequent rollers which move in opposite directions, thus forming a curtain of coal which falls uniformly from roller to roller until it reaches the bottom bin from which it is discharged continuously. The hot gases, produced by any suitable furnace, enter the dryer at the base and rise through the descending coal. Baffles in the dryer and the arrangement of rollers compel the gases to pass through the coal curtain several times ensuring intimate counter current contact between the whole of the gas and the whole of the feed. The amount of dust discharged from this type of dryer is claimed to be substantially less than would be normally expected as the upper stages of the wet ribbon of coal filter

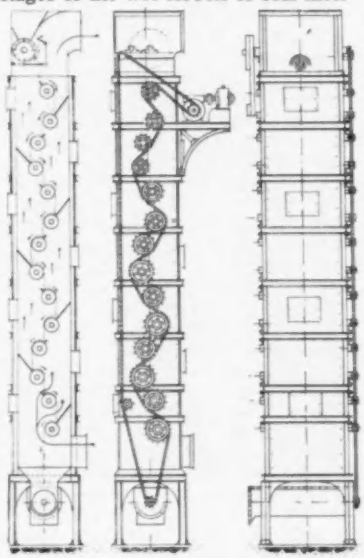


Fig. 3 (left). Elevations and cross-sectional arrangements of the Conreur vertical roller coal dryer. (Neldco Processes Ltd.)

the gases before they leave the dryer. It is, of course, always necessary to have some dust collecting equipment, but the size of this can be comparatively small. A special feature of the Conreur dryer is its ease of control. Final moisture content can be maintained within close limits, and no recirculation of dried products is necessary. (*Neldco Processes Ltd., Ashford, Middlesex.*)

Mercuryless diaphragm meter

Foxboro-Yoxall Ltd. have recently introduced a new mercuryless meter (Type-37) to measure a range of differential pressures from 20-in. to 200-in. of water, at static pressures up to 2,000 lb./sq. in. The new instrument has a frictionless flexure-pivoted drive unit of exceptional sensitivity; positive protection against over-range with no zero shift; a simple method of range change; a built-in temperature compensation for all differential ranges and full range damping which is adjustable under pressure. An entirely new and flexible diaphragm assembly is used for the measurement of differential pressure. Preformed discs are welded by a special process and shaped to nest into the adjacent disc and each is welded to a spacing ring. Excess pressure in either chamber will compress the diaphragm assembly until each pair of discs is nested and the spacing rings have contacted to form a metal to metal stop. The drive unit is of solid rods joined by a metal flexure and forms a direct connection between the diaphragm assembly and the pen lever. The fulcrum is formed of two similar flexures and the seal is a flexible bellows capable of withstanding pressures 50 per cent. above the meter rating. This drive transmits the smallest measurement changes to the pen with extreme accuracy. The special range spring, the temperature compensator and the damping valve are exclusive Foxboro-Yoxall Ltd. design features and their incorporation make the new Type-37 and exceptionally reliable and accurate mercuryless meter. (*Foxboro-Yoxall Ltd., Redhill, Surrey.*)

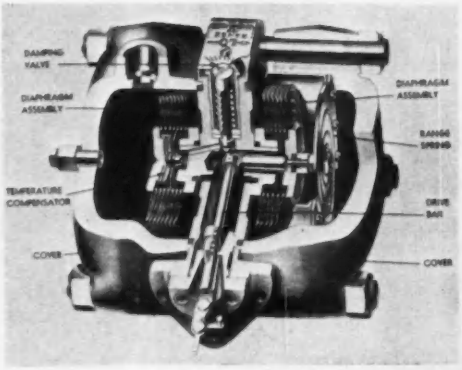


Fig. 4 (above). A cutaway view of the new type-37 mercuryless meter. (Foxboro-Yoxall Ltd.)

Simple rig for weld preparation

Reduced cost and greater output in the preparation of tubes for butt-welding have been achieved at a well-known Glasgow engineering and boiler works by the use of simple portable rigs which consist of a Consolidated Pneumatic type-350-R-100 heavy-duty power-vane drill mounted in line with two ball-races and a vice on a common base-plate. The drill is fitted with a No. 5 Morse taper spindle which is held rigidly by the ball races spaced 5½-in. apart. A specially-designed cutter head carrying two Cleveland twist drill cutters of 10 per cent. cobalt steel is mounted on the spindle, the head carrying recesses for cutting teeth suitable for dealing with tubes in the size range of 1½-in. o.d. to 6-in. o.d. and thicknesses of from 10 gauge up to ½-in. The Consolidated Pneumatic type-350-R-100 air drill is a standard reversible model and has a spindle speed, when running light, of 100 r.p.m. It has an overall

Fig. 5 (right). Operator using the new portable rig for the preparation of tubes for butt-welding. (Consolidated Pneumatic Tool Co. Ltd.)

length of 22¾-in. and a weight of 85¾-lb. The standard drill is fitted with feed screw, safety live-air throttle and dead handle. (*Consolidated Pneumatic Tool Co. Ltd.*, 232, *Dawes Road, London, S.W.6.*)

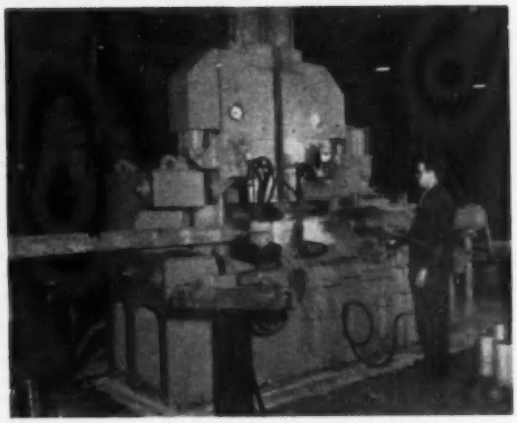
Flame safeguard and programming control

A new form of flame-failure safeguard and programmer control, designed specifically for the smaller pressure-type gun burners burning light oil, and also applicable to the smaller "packaged" boilers fired with light oil, has been introduced, by Fireye Controls Co. Ltd. Known as the System FJ-2, the equipment incorporates the company's single type 48PT1 scanner and the type 29RF5 control. It uses the Fireye

Fig. 6 (left). The Fireye System FJ-2, incorporating the programming controller (type 29RF5) and scanner (type 48PT1). (Fireye Controls Co. Ltd.)

lead sulphide cell, which visually detects both gas and oil flames—the resistance of the cell varying, when it "sees" infra-red radiation. The electronic circuit amplifies only the pulsating frequency peculiar to flame radiation, and the system thus easily discriminates between flame and hot refractory, or other sources of infra-red. The scanner supervises both the pilot and main flames, and the system does not allow the main fuel valve to open unless the pilot flame has been established. Where direct electric spark ignition is used, the control allows the main fuel valve to open for a five second "trial-for-ignition" period. If flame-failure should occur, the system shuts off all the fuel within two to four seconds. The control incorporated programmes the operating sequence of blower and/or burner motor, ignition, and fuel valve. It also provides a purge period before and after each firing period. The control cycles automatically during normal operation on a call for heat, but must be reset manually following flame-failure. System FJ-2 includes a "safe start" interlock whereby component failure within the Fireye equipment, or the presence of actual or simulated flame prior to start-up will prevent burner operation. (*Fireye Controls Co. Ltd.*, 14, *Fetter Lane, London, E.C.4.*)

Fig. 7 (right). The type APFH/18T, heavy-duty flash butt-welding machine. (A.I. Electric Welding Machines Ltd.)



Heavy-duty flash butt-welding machine

A.I. Electric Welding Machines Ltd., are adding to their range, a new heavy-duty flash butt-welding machine (Type APFH/18T), which is a combined tube and general purpose machine with a maximum welding capacity of 12 sq. in. (sectional area) in mild-steel. The new machine incorporates provision for welding tubes up to 6½-in. diam. A fettling unit can be fitted to the right-hand end of the machine to remove internal weld upset when welding short tubes to longer lengths as, for instance, in the re-ending of boiler tubes, etc. The type APHF/18T employs one fixed, and one sliding clamping unit, operated from a two-stage air/oil intensifier system from an 80/100 lb./sq. in. air supply. Initial low-pressure, direct from an air cylinder, applies a load of one ton, which is intensified to 27 tons for final clamping. The 6-in. vertical clamping stroke allows for a wide variation in size and shape of workpiece. Vertical and horizontal adjustment under full clamping pressure is available on the left-hand head for accurately aligning the tubes or components to be flash butt-welded. The forging unit uses the same air/oil intensification principle to apply 18 tons pressure without recourse to the complexities of pumps, high-pressure pipe, couplings, etc. Preheating may be accomplished manually by means of a control lever which reciprocates the sliding clamp unit so as to make and break contact between the mating surfaces, or alternatively, for batch production, automatically as part of a pre-set work cycle. A 350-kVA water-cooled single-phase transformer is mounted as a separate unit at the rear of the machine. Air and water demands are 20 cu. ft. of air at 80/100 lb./sq. in. per weld, and 240 gal./hr., respectively. (*A.I. Electric Welding Machines Ltd.*, 68, *Victoria Street, London, S.W.1.*)

Two-pressure hydraulic throttling valve with neutral position

Hunt & Mitton Ltd. announce a new range of pneumatically-operated valves to control hydraulic presses and similar machinery. These valves are designed to allow the operator to:—(a) hold a neutral position on the ram at any point on its upward or downward travel; (b) slow down the speed of the ram during the last few inches of travel in order to minimise wear on the locating pins of the mould; (c) to close the press on low-pressure, and to "kick-in" the high-pressure either immediately the press is closed, or after a predetermined delay time. The valve is suitable for operation either by manual pilot valves, or by an electric timer. The design of the valve has been carefully worked out so as to ensure smoothness in operation. Stems are in hydraulic balance. The spacing of the ports is claimed to lessen hydraulic shock, and to protect the seats from the cutting action of high-velocity fluid. The seat sleeve is extremely hard (500 to 550 Brinell). As it registers in the body bore, it requires no special wrenches for assembly. This type of construction also insures against seepage through the seats, due to body breathing. Seat sleeves may be turned end for end, thus exposing a new, unused seat for continued use. Valve discs are of stellite, while the stems are of hardened K monel,

hard chrome plated to ensure smoothness of operation, and reduced packer wear. The valve incorporates a check valve to prevent the high-pressure flowing into the low-pressure line. The high-pressure inlet valve is spring loaded to ensure that it closes immediately pressure is released from the ram, thus preventing useful high-pressure fluid being lost to drain. These valves are suitable for oil or water at pressures up to 4,000 lb./sq. in. and are made in sizes ¾-in. to 3-in. (*Hunt & Mitton Ltd., Oozells Street North, Birmingham, 1.*)

New flow recorder

A new Arkon flow recorder (Model 1602) has been specifically designed for the measurement of high-pressure gas, compressed air, steam, water and other liquids. It embodies the simple design, and robust construction common to all Arkon recorders, and uses the well-established principle of mercury U-tube and float, overload protection being incorporated. The recorder is fitted with a dual valve (instead of the three-cock assembly usually met with in this type of recorder) which incorporates automatic equalising. These features eliminate the possibility of mercury being blown into the impulse lines as the result of incorrect operation of valves or surges of pressure. The operating valves are placed inside the recorder case and accessible from the front of the instrument. The Model 1602 has been provided with an easily-read chart, the visible width of which covers a period of 16 hours, making it easy to follow the record over the whole of a normal shift. A roll of chart lasts for six weeks, and may be left on the rewind roller for as long as a week or cut-off daily, or as required. The free end of the chart can be left to travel over the chart plate as it is picked up automatically on the collecting spool. This saves a considerable amount of time where charts are collected daily and also prevents irritating breaks in the record through failure to reset the chart correctly. Where the instrument is required to total the flow automatically, an electrically-operated integrator can be fitted as an optional extra. Charts can be supplied reading in cu. ft./hr., gal./hr., lb./hr., inches w.g., differential pressure or any units to meet user's requirements. Differential ranges from 60-in. to 200-in. w.g. Model 1602 recorders are designed for operations under static pressures up to 300 lb./sq. in. (*Walker, Crosweller & Co. Ltd., Cheltenham.*)

New London Clock

Travellers from the north and elsewhere who arrive at Euston, Kings Cross or St. Pancras railway stations, and the millions of people who pass along the Euston Road, now have a landmark. It is the 12-ft. diameter face of a new and imposing illuminated clock, 110-ft. above street level, surmounting the new eight-storey Babcock House, the London headquarters of Babcock & Wilcox Ltd. It is neon-lit and "contemporary" in style, its white hands contrasting with hour motifs in glowing red. The clock is associated with a large blue neon-lit sign, "Babcock," in Franco "Lumina" letters with blue "Perspex" faces and metal returns, arranged vertically on the end of the building. The visual design for the clock face and name display was produced by the company's publicity department, and the manufacture and installation were carried out by the Franco-British Electrical Co. Ltd. (Franco Signs). The clock has been erected within the lift tower on top of the building, and is operated by a weight-driven electrically-wound tower type clock movement, mounted on a rigid steel stand with inter-connecting couplings and precision-bevelled gears.

View during hours of darkness of the new 12 ft. diam. illuminated clock face surmounting Babcock House.

It is stated that the oil-firing course held by the **National Industrial Fuel Efficiency Service** on January 13th, 14th and 15th, was filled very soon after the course was announced. A further course has, therefore, been arranged at N.I.F.E.S. Office, Ailsa House, Kings Road, Reading, on April 14th, 15th and 16th, 1959. As some of the places have been taken up by those who could not be accepted into the January course, early enrolment is recommended. The course is designed to meet the needs of industrial plant engineers, heating engineers, and supervisory staff responsible for oil-fired boiler plant. The fee for the course, exclusive of hotel accommodation, will be six guineas. Application forms and a course syllabus may be obtained from N.I.F.E.S., 71, Grosvenor Street, W.1.

* * *

Teddington Industrial Equipment Ltd., makers of the Spediflam II series, announce a new service exchange scheme for burner controls. As from January 1st, 1959, any obsolete Teddington burner watchers, stack switches, viewing heads or room thermostats of *any* other make *irrespective of age or condition,* will be accepted in exchange for current Teddington equivalents at the special trade-in prices. This new scheme, which makes a generous allowance for old controls includes arrangements to provide off the shelf delivery of all current models in the Spediflam II range.

James Gordon Valves Ltd. has been formed to take over the valve activities of James Gordon & Company Limited, a member of the Elliott-Automation Group. The new company will handle the design, manufacture and sale of the specialised Gordon range of control valves, which include tight-shutting butterfly valves developed during recent years for such applications as gas-cooled nuclear reactors and wind tunnel dampers. James Gordon Valves Limited will have its headquarters at Airport Works, Rochester, which is already the home of the other valve companies within the Elliott-Automation Group. The directors are Messrs. G. C. Fairbanks, H. Masheder, J. E. O'Breen and H. R. Walton.

* * *

A.E.I. Turbine-Generator Division announce that **Mr. P. A. J. Manley,** S.I.Mech.E., has been appointed assistant superintendent, Large Turbine Department, Trafford Park. Mr. Manley joined Metropolitan-Vickers Electrical Co. Ltd. in 1952 as a college apprentice. On completion of his apprenticeship he joined the Mechanical Department, and has since been associated throughout with the manufacture of large and medium size steam turbines. He became chief production engineer, Mechanical Department, in 1955, retaining the position until his present appointment.

* * *

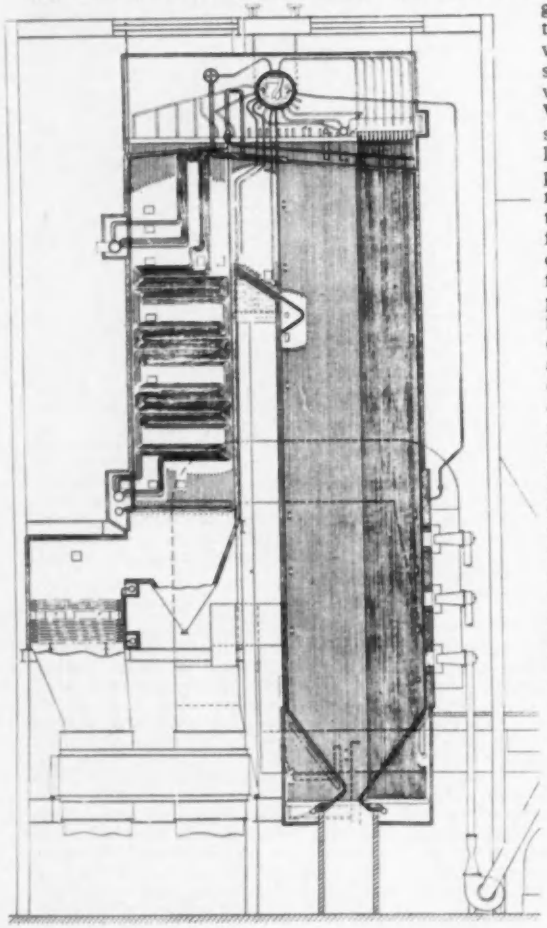
A very comprehensive and well produced publication (4MID58) by **Babcock & Wilcox Ltd.,** describes the company's range of boiler cleaning tools. This 32-page brochure is divided into two sections. The first covers mechanical appliances and deals in turn with water-driven, air-driven and electrically-driven tube cleaners, these remarks being followed by details of the various types of drills, cutters and brushes available for use with these machines. Notes are also included on the operation and care of tube-cleaning machines. The second section is devoted to hand-operated tube cleaning equipment and other tools for boiler maintenance.

OVERSEAS Steam Engineering Practice

Abridgments of recent articles in the colonial and foreign technical press, concerning design and progress in the technique of steam generation and power plant equipment

Twin-furnace dual circulation steam generator

The Meramec No. 3 steam generating unit of the Union Electric Co., St. Louis, U.S.A., which is now nearing completion, is a Foster Wheeler Corporation., twin-furnace, dual-circulation type boiler, designed for a c.m.r. of 1,850,000 lb./hr. at a pressure of 2,450 lb./sq. in. The final steam temperature leaving the superheater furnace is controlled at 1,100 deg. F. from 1,390,000 to 1,850,000 lb./hr. at a pressure of 2,150 lb./sq. in. Correspondingly the maximum continuous reheat steam flow is 1,685,000 lb./hr. at a pressure of 529 lb./sq. in. and a reheat outlet steam temperature of 1,010 deg. F. is to be maintained over a reheater load range of 1,275,000 to 1,685,000 lb./hr. Each furnace of the No. 3 unit has identical construction; radiant superheater, division wall, boiler section and burner protection tubes circuits. Steam generated in the water tubes enters the drum where the steam is separated from the water by Foster Wheeler horizontal separators. Steam leaves the drum after passing through chevron dryers and enters the superheater. Steam from the radiant superheaters of each side flows through the respective walls at the front and rear of the convection gas passage and then mixes in the convection superheater inlet header on the superheater side. All the steam generated in the two furnaces passes through the main bank of the convection superheater and to the high-pressure turbine. After passing through the high-pressure stages of the turbine, it flows to the convection reheater in the reheater unit and is then returned to the low-pressure turbine. Reheat units using convection superheating only are limited in range over which full design steam temperature may be obtained. However, by using the radiant superheater in each furnace in combination with a convection superheater, it is possible to maintain design steam temperatures without having to utilise the high furnace exit temperature normally required if all convection superheating and reheating surface were used. Thus it is possible to maintain furnace exit gas temperatures that satisfy the fuel characteristics, particularly slagging properties of the ash. Since the steam temperature leaving the radiant superheater decreases with increase in boiler rating, while that from a convection superheater increases with rating, the series combination of these superheaters results in a steam temperature which is inherently flat and requires a minimum of control within the design range. Steam temperature is controlled by condenser-type heat-exchangers located in the radiant superheater inlet headers. Control of primary steam temperature contains two temperature limiting elements: (1) Function of the first element is to limit the average steam temperature leaving each radiant superheater to 910 deg. F. at low loads; (2) Function of the second element is to control the final steam temperature of the total steam flow from the convection superheater outlet header to 1,010 deg. F. within the control range. Reheater outlet temperature is controlled by varying the firing rate in the furnace on the reheat side. Thus the expected firing ratio in the reheat side to that in the superheat side is 60/40 at half load, 57/43 at three-quarter load, and 50/50 at full load. Steam is generated in the rear waterwall, division waterwall, and portions of the side waterwalls in the furnaces, and in the side waterwalls of the convection superheater and reheater enclosure on the respective sides of the unit. The first five tubes on either side of each burner are water cooled. Heat recovery equipment



Cross-sectional arrangement of the superheater side of the Meramec No. 3 steam generating unit. This is a twin-furnace dual-circulation type boiler, designed for a c.m.r. of 1,850,000 lb./hr. at 2,450 lb./sq. in.

consists of an extended surface economiser and a regenerative type air preheater for each side of the unit. The steam generator is fired by pulverised coal, with provisions for future natural gas firing. Coal is pulverised in three D-8-D Foster Wheeler ball mills serving 24 inter-vane pulverised coal burners, 12 to each side, arranged in rows of four at three elevations. The mills are double-ended with raw coal being fed to both ends and pulverised coal being drawn from both ends of the mill. The pulverised systems have been so arranged that each mill supplies fuel to one row of burners in each side, one end of the mill serving the superheat side and the other end serving the same burners of the reheat side. Each exhauster serves four burners, two on each side of the division wall of the divided furnace for balanced firing in that furnace. The dual circulation principle incorporated in the Meramec Plant No. 3 unit permits the maintenance of low concentrations of silica in the primary section with a minimum of blowdown from the unit, thus assuring the minimum carryover of silica in vaporised or mechanically entrained form. Two separate steam generating sections, each with its own circulating systems, are provided in the dual circulation boiler design. The primary section consists of the side, rear, and front portion of the division waterwalls, aperture walls and heat recovery enclosure walls. The secondary section is made-up of a complement of tubes located in the rear portion of the division wall. Feedwater is introduced to the steam drum of the primary section from which it flows to the waterwalls after first being mixed with the boiler water in the drum. The blowdown from the primary section becomes the feedwater for the secondary section. With this arrangement, the concentration of silica in the primary section is maintained at a considerably lower value than in the secondary section. The ratio of concentration in the two sections is dependent on the steam generated in those sections and the amount of blowdown from the secondary section. By maintaining the low concentrations of silica in the primary section, where most of the steam is generated, the carryover of this constituent is minimised. Provisions are made in the Meramec No. 3 unit for condensing the steam generated (14 per cent.) in the secondary section. This is done by bringing incoming feedwater into direct contact with secondary section steam in condensing compartments arranged along the central portion of the 66-in. i.d. drum. Since nearly all of the steam generated in the secondary (high concentration) section is condensed, most of the steam leaving the boiler is produced in the primary (low concentration) section. Salts in the steam, including those in vapour form, will be in equilibrium with the higher purity water in this section. It is also possible to return some of the concentrated water from the secondary section to the primary section in order to obtain greater flexibility of chemical control. The amount of recirculation is controlled by manual adjustment of valves in lines arranged between the secondary section and the downcomers of the primary section. (*Heat Engineering*, Vol. 33, No. 4, pp. 150/153.)

Fluidrive Engineering Co. Ltd. inform us that in connection with the reorganisation and expansion of the engineering sales department under **Mr. W. H. K. James, Mr. J. W. Lee** has been appointed sales manager. As regards the estimating, engineering application, tendering and specialised customer contact, **Mr. A. W. R. Willis** becomes chief application engineer (motors), mainly concerned with electric motor drives, and **Mr. R. V. Adams** chief application engineer (engines), mainly concerned with engine drives.

* * *

The A.E.I.-John Thompson Nuclear Energy Company Limited announce the following recent appointments. **Mr. S. A. Ghalib** as general manager of the company; **Mr. J. R. M. Southwood** as chief engineer; **Mr. B. M. Bonfield** as secretary of the company; and **Mr. A. R. Laing** as assistant secretary. Mr. Ghalib, who was a college apprentice with Metropolitan-Vickers Electrical Company Limited, was appointed a group leader of the A.E.I.-John Thompson Nuclear Energy Company Limited in September, 1954, and, on the formation of the company in 1956, was made chief engineer.

* * *

The Goodyear Tyre & Rubber Co. (Great Britain) Ltd., announce the appointment of **Mr. T. F. Minter** in succession to Mr. M. S. MacDonald, as manager of their Scottish plant at Garscadden, Glasgow. Mr. Minter was formerly manager of technical services at the Goodyear organisation headquarters in Akron, Ohio. Mr. MacDonald has returned to the Goodyear headquarters at Akron where he will, we understand, take up another position.

Dr. Sydney Jones, Ph.D., B.Sc., A.M.I.E.E., head of the Armament Department of the Royal Aircraft Establishment of the Ministry of Supply, has been appointed director of research and development (electrical) of the Central Electricity Generating Board as from February 2nd, 1959. Dr. Jones joins **Mr. F. C. W. Colmer, Mr. R. Ll. Rees** and **Dr. J. S. Forrest** as directors of branches of the research and development department of the Central Electricity Generating Board. Mr. Colmer is responsible for research and development (technology); Mr. Rees for research and development (operations); and Dr. Forrest for the Leatherhead Laboratories.

* * *

The General Electric Co. Ltd. announces that following the integration of the Witton and Erith works, it has made the following new appointments: *Witton Engineering Works*, **Mr. T. H. Kelsey,** assistant general manager; **Mr. J. W. Laing,** chief engineer; **Mr. J. S. Cliff** and **Mr. E. Gallizia,** assistant chief engineers; **Mr. A. E. Taylor,** engineering liaison officer between the home branches and Witton and Erith. *Erith Engineering Works*: **Mr. B. S. Pelton,** manager, general engineering division, and **Mr. D. M. Smith,** manager, power plant division. *Head Office*: **Mr. C. J. O. Garrard,** manager, engineering department, *London*; **Mr. E. W. Molesworth,** personal assistant to Mr. A. L. G. Lindley. The following have been appointed managers of the engineering departments at the main branches: **Mr. J. R. Mercer,** *Glasgow*; **Mr. V. F. Ellison,** *Newcastle*; **Mr. O. S. Chalmers,** *Manchester*, and **Mr. W. R. Greves,** *Birmingham*.

The death occurred on January 3rd, 1959, at Winterthur, Switzerland, at the age of 82, of **Dr. Hans Sulzer,** president of the well-known Swiss engineering company of Sulzer Brothers Limited, and senior member of the board of Sulzer Bros. (London) Ltd. In addition to his family interests in the engineering field, Dr. Sulzer played a leading part in the industrial and economic life of Switzerland and was well known internationally. His activities embraced banking, insurance and mining, and he served on the boards of several companies. He also played a leading part in the affairs of the Swiss and International Chambers of Commerce and in the field of industrial relations. During the 1914/18 War, Dr. Sulzer represented his country in Washington, and when, after the outbreak of the last war, the economic situation of Switzerland became precarious, he was invited by his government to lead a mission to London to seek recognition of Switzerland's position as a neutral country and assurances and assistance with regard to essential supplies of food and materials.

* * *

The British Cast Iron Research Association has made the following appointments, effective from January 1st, following the retirement of the director, **Dr. J. G. Pearce,** at the end of December:—**Mr. H. Morrogh,** director; **Dr. H. T. Angus,** deputy director; **Mr. T. E. Whiteside** will continue as secretary.

* * *

The Junior Institution of Engineers announces that **Mr. W. C. C. Ball** has been elected chairman, and **Mr. E. M. Baskerville** and **Mr. E. E. Burrage,** M.I.Mar.E., vice-chairmen.

Latest Power Plant Patents

These extracts from British Patent Specifications are reproduced by permission of The Controller of H.M. Stationery Office. (Complete British Specifications can be obtained from the Patent Office, 26, Southampton Buildings, London, W.C.2. Price 3s. 6d. each, both inland and abroad.)

Supercritical steam plant

In the plant shown in Fig. 1 there are two turbines (37) and (60) in parallel with one another in the supercritical stage. The turbine (37) drives a pump (33) by which water from the steam and water drum (12) is passed under supercritical pressure to the generating tubes forming the main water heating surface (14) of the boiler. The turbine (60) drives a steam compressor (64) between the outlet of a high-pressure turbine stage (21) and a reheater in the subcritical side of the plant. The working fluid can be traced through the plant from the steam and water drum

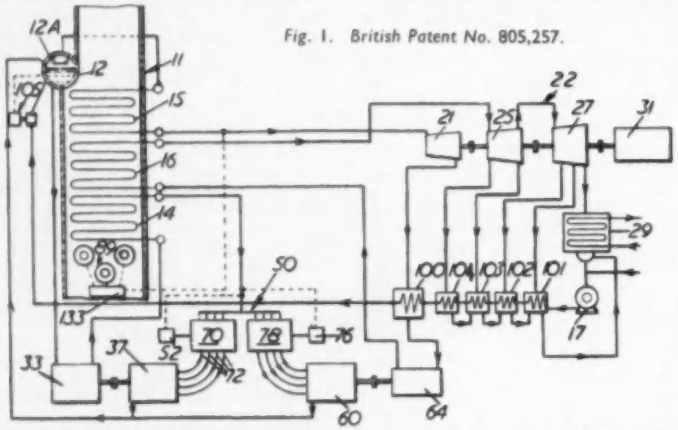


Fig. 1. *British Patent No. 805,257.*

(12) through the supercritical stage being subjected to supercritical pressure in the pump (33). It is heated, and changed without boiling to a true gas in the section (14) of the boiler and distributed between the turbines (37 and 60) by valve mechanism (50). The steam is cooled and reduced in pressure in the two turbines and passed as a wet vapour to the steam and water drum (12). In the subcritical side of the plant the working fluid passes from the drum (12) by way of a steam separator (12A) in which entrained water droplets containing dissolved solid contaminants are removed from the steam. The dry steam then passes through a superheater (15) and then successively through the high-pressure turbine stage (21), a feed-water heater (100), the steam compressor (64), the reheater (16), an intermediate pressure turbine stage (25), and a low-pressure turbine stage (27). Steam exhausts from the turbine stage (27) into a condenser (29). Condensate from the condenser (29) is pumped by a pump (17) through a series of four regenerative feedwater heaters (101, 102, 103 and 104) and the heater (100) to the drum (12). The heaters (101 and 102) are heated by steam bled from the turbine stage (27), and by steam bled from the heaters (103 and 104) which receive bled steam from the turbine stage (25). Condensate from the four heaters is passed to the hot well of the condenser (29). The supply of feedwater to the drum (12) is regulated by a control valve (105) so as to maintain a uniform water level within the drum. The boiler is fired by a group of burners (89) under control of a pressure sensitive controller (133) responsive to the pressure at the outlet of the superheater (15). The turbine stages (21, 25 and 27) form turbine set (22) which can be used to drive an electrical generator (31). *British Patent No.* 805,257 *issued to Foster Wheeler Ltd. Complete specification published December* 3*rd*, 1958. (*Pat. of Addition to* 761,617.)

Combined superheater and steam generator for nuclear marine plant

This invention relates to a heat-exchanger provided with a furnace and adapted to alternatively generate steam or to superheat steam, and a steam power plant including such a unit. In a marine plant a reduced quantity of steam is required, partly as a reserve in the event of a breakdown of the main plant, and partly for manoeuvring the ship into or out of harbours with the reactor shut down. During a stay in harbour steam is also needed for driving auxiliary plant only, although this is considerably less than the amount required when the ship is at sea. In industrial plants, where the steam demand during working hours may be comparatively great, it is necessary to make available a small quantity of steam during holiday periods. In cases of this kind, the whole plant will be considerably simpler if a separately fired superheater is arranged in such a manner, that it may alternatively be used for generating a certain quantity of steam. A superheater according to the invention is designed as a heat-exchanger consisting of tube banks which run from an inlet to a collecting header,

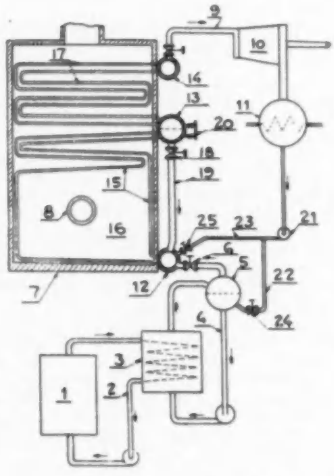


Fig. 2. *British Patent No.* 805,408.

from which a return pipe provided with shut-off valves leads back to the inlet. Shut-off valves for steam and feedwater respectively are arranged in the piping connected to the heat-exchanger. In Fig. 2 a reactor (1) is shown, which is cooled by a suitable medium, circulating through

a piping system (2), in which there is included a heat-exchanger (3). Steam is generated indirectly in a second circulating system which includes piping (4) and a steam drum (5). The steam generated is conveyed by means of a pipe provided with a shut-off valve(6) to a heat-exchanger (7), which is encased in a furnace provided with the fuel-oil burner (8). The superheated steam leaves the heat-exchanger through pipe (9) and is conveyed to a turbine (10). The steam exhausted from the turbine is returned as feedwater to the primary steam generating plant or to the heat-exchanger. The heat absorbing section of the heat-exchanger consists of tube banks, which are connected to three headers (12, 13 and 14) respectively. From the lower of these runs a tube bank (15) which first covers the walls of the furnace (16), and then forms a convection heating surface in the combustion chamber. The tubes are then connected to the middle header (13). From this a second bank of tubes (17) runs through the upper part of the combustion chamber to the upper header (14), to which the steam outlet pipe is connected. Between the middle header (13) and the lower header (12) a return flow pipe (19) is provided, which has a shut-off valve (18). The middle header has sufficient volume to allow it to serve as a steam drum. The feedwater obtained in the condenser may, by means of a pump (21), be conveyed either through a pipe (22) to the steam drum (5) or through a branch pipe (23) to the lower header (12). In each of the supply pipes there is a shut-off valve (24 and 25) respectively. During normal operation the steam generated in the primary system is led to the heat-exchanger (7), where it first passes tube bank (15) and then tube bank (17). By regulating the combustion rate, a suitable degree of superheat is easily obtained. During normal conditions the steam generated in the primary system is led to the heat exchanger (7), where it first passes the tube bank (15) and then tube bank (17). By regulating the firing rate the required degree of superheat is obtained. When the nuclear reactor is shut down, the design of the separately-fired superheater makes it possible to generate steam in this section only, and the heat-exchanger should be of such dimensions that it is capable of generating the amount of steam required. Through proper adjustment of the heating surfaces of the two tube banks it is also possible to obtain approximately the same degree of superheat with the amount of steam generated in the heat-exchanger. When steam is to be generated in the heat-exchanger, the feedwater supply to the steam drum (5) is shut off by means of valve (24). At the same time the valves (18 and 25) are opened, and the heat-exchanger is filled with water to a desired level. By means of suitable regulating devices further feedwater is supplied in such a manner that this level is constantly maintained. The tube bank (15) and the return pipe (19) form, together with the headers (12 and 13), a circulating system for the water in the same manner as in a boiler of conventional design, and steam is collected in the drum (13). During the passage through bank (17) the steam will be superheated and then led to the turbine. *British Patent No.* 805,408 *issued to A. B. Götaverken. Complete specification published December* 3*rd*, 1958.

Control of forced flow boiler

This invention relates to forced-flow, one-through boilers and to a device for controlling this type of unit through temperature-sensitive control gear, the operation of which is dependent upon the temperature sensed at the end of at least one of the boiler tubes. In Fig. 3 a boiler is shown diagrammatically, having three parallel connected groups of tubes (*A*, *B* and *C*) in the end zone of water heating, the zone of evaporation, and the beginning of superheating. Each group (*A*, *B* and *C*) comprises four parallel connected tubes. The outlet of each tube of the groups (*A*, *B* and *C*) is connected to an outlet header (20). The inlet ends of the tubes (1, 2 and 3) originate in an inlet subheader (28), those of tubes (5, 6 and 7) in an inlet subheader (30); and those of tubes (9, 10 and 11) in an inlet subheader (32). The fourth tube of each group, namely (4, 8 and 12) respectively, by-passes the inlet subheader associated with the group and is connected directly to a main inlet header (34). The inlet subheaders (28, 30 and 32) are also connected to the main inlet header (34) by means of conduits (36, 38 and 40) respectively. Water flows from a feedwater source through a feed pipe (42) into the main inlet header (34). A flow control device such as a valve (44) in the feed pipe (42) controls the amount of water fed to the main inlet header (34). The pipes (36, 38 and 40) distribute the water to the inlet subheaders (28, 30 and 32) respectively. On the other hand the tubes (4, 8 and 12) receive water directly from the main inlet header (34). Flow control means, such as valves (46, 48 and 50), are provided in the pipes (36, 38 and 40); and such as valves (52, 54 and 56) in the tubes (4, 8 and 12) respectively. Under normal operating conditions the water entering the tube groups (*A*, *B* and *C*) is evaporated to such a degree that only a slight residue of water remains in the steam entering the outlet header (20). The saturated steam and the small amount of water which carries a major portion of the impurities, pass from the outlet header (20) into a steam and water separator (58) by way of pipe (60). The separator (58), which may be of the centrifugal type, separates most of the water plus impurities from the steam. The purified steam leaves through a pipe (62) and enters a superheater (not shown). The water together with the impurities contained in it is blown down through a pipe (64) and a valve (66) to a sump. Each of the tubes (4, 8 and 12) of the groups (*A*, *B* and *C*) respectively has associated with it a temperature-sensitive signal transmitter (68, 70 and 72). Each transmitter is connected through a separate transmission line with a selector mechanism (74), which on its part influences a regulator (75) through a transmission line (76). The transmitters are associated with a selector mechanism which permits the transmission of a signal only from the signal trans-

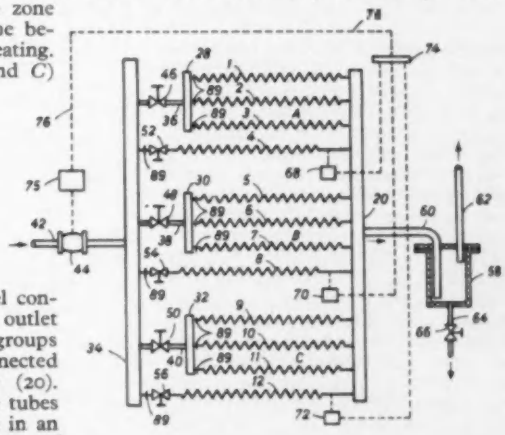


Fig. 3. *British Patent No.* 806,561.

mitting device of the tube which is then sensing the highest temperature. *British Patent No.* 806,561 *issued to Sulzer Freres S.A. Complete specification published December* 31*st*, 1958.

Steam turbine plant

This invention relates to steam turbine power plant of the cross-compound, reheat type, in which the turbines and generators are coupled in tandem on two shafts which rotate at the same speed. A typical plant embodying the invention is outlined in Fig. 4. High-pressure steam from boiler (*B*) passes through a superheater (1) and under control

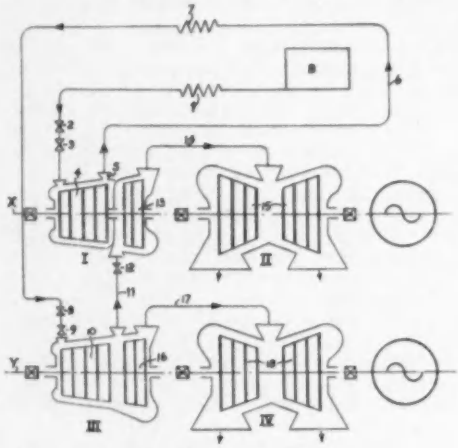


Fig. 4 (left). *British Patent No.* 806,611.

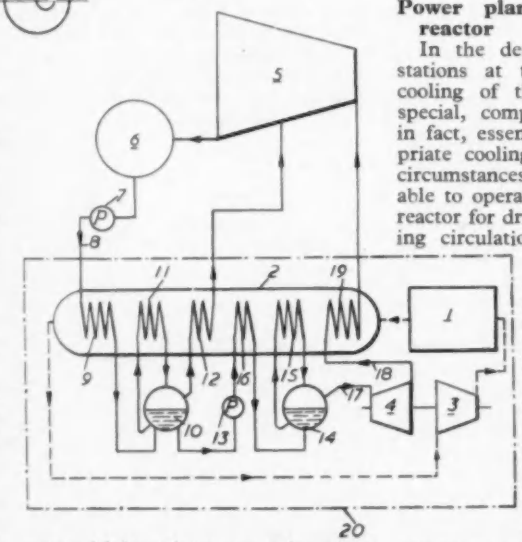


Fig. 5 (below). *British Patent No.* 806,589.

of the emergency and governor valves (2 and 3), enters the high-pressure section (4) of the first turbine No. 1 on shaft (*X*). After passing through section (4), the steam is led via outlet connection (5) and pipe (6) to a reheater (7) and then through appropriate piping and intercept emergency and governor valves (8 and 9), to the primary intermediate-pressure section (10) of the turbine No. III on shaft (*Y*). After expansion to a pressure determined by the reheat pressure so that the total power distribution between the axes will be equal, the steam divides. Half the quantity of steam leaving section (10) passes through a crossover (11) and an emergency valve (12) to the secondary intermediate-pressure section (13) of the turbine No. 1, and ultimately through ducting (14) and the sections (15) of double-flow low-pressure turbine No. II. The remaining half of the steam from section (10) expands through the secondary intermediate-pressure section (16) of the turbine No. III and passes through ducting (17) to the low-pressure cylinders (18) of turbine No. IV. Section (13), ducting (14) and turbine No. II on shaft (*X*) are duplicates respectively of section (16), ducting (17) and turbine No. IV on shaft (*Y*). By adjustment of the pressure in cross-over (11) unequal power distribution between the shafts (*X* and *Y*) can be obtained if required. This turbine arrangement offers several advantages. In the usual arrangements of cross-compound turbine plant, the low-pressure turbine or turbines are located on one or more secondary shafts only, which may run at a slow speed permitting the use of very long blades in the final stages to provide the considerable exhaust area required for large ratings. Such an arrangement can result in an expensive, heavy low-pressure element with large interconnecting pipes or ducts. In the arrangement according to the invention the high-speed low-pressure turbines on each shaft can be of the double-flow type, and the necessary exhaust area is provided by four final stages permitting a compact arrangement of plant of large output. For example, using low-pressure turbines similar to those which have been developed for standard 100-MW non-reheat machines, a total output at a high performance of 250/300-MW would be possible with conditions of say, 2,400 lb./sq. in., and 1,050/1,100 deg. F., with reheat to 1,000/1,050 deg. F. Secondly, with the large condensers required for ratings of 250-MW or more, the use of exhausts on two shafts would tend to reduce basement depth. The floor area of plant arranged according to the invention, with auxiliaries between the two shafts, would be of the same order as, or very little greater than, that of a tandem-compound plant of similar output with a single shaft. Thirdly, with equal powers at the same speed from each shaft, the generators can be identical; also the secondary intermediate-pressure sections and the low-pressure turbines on both shafts can be identical. A further advantage is that the steam connection between the shafts being in the intermediate-pressure portion of the expansion, the size of interconnecting piping will be smaller than that required if connections were at the inlet to the low-pressure element. *British Patent No.* 860,611 *issued to Metropolitan-Vickers Electrical Company Ltd. Complete specification published December* 31*st*, 1958.

Power plant with gas cooled reactor

In the design of nuclear power stations at the present time, the cooling of the reactor necessitates special, complex apparatus. It is, in fact, essential to maintain appropriate cooling of the reactor in all circumstances, which requires motors able to operate independently of the reactor for driving the blowers effecting circulation of the cooling gas. Special regulating apparatus is required to regulate the forced-draught power when variations in the heat liberated in the reactor occur. An object of this invention is the provision of simplified means for ensuring the requisite gas circulation through the reactor for cooling purposes. Fig. 5 shows a diagrammatic arrangement of a power plant in which a nuclear reactor (1) is gas-cooled, the gas being circulated under pressure in a closed circuit indicated by broken lines, and being heated in the reactor, cooled in the heat-exchanger (2) and delivered to the reactor by a blower (3) driven by a steam turbine (4). The heat-exchanger (2), which includes a low-pressure steam generator (11) and a

high-pressure steam generator (15), serves to generate and superheat steam for driving a main steam turbine (5) forming part of a turbo-alternator installation. Exhaust steam from the turbine (5) enters a condenser (6), and the condensate is returned to the heat-exchanger (2) by a feedpump (7) through a pipe (8). The installation also comprises, in general, extraction pumps and regenerative feedwater heaters (not shown). The heat-exchanger could, of course, include more than two steam generators adapted to operate at different pressures, decreasing from steam generator to steam generator in the direction of coolant flow. The water delivered through the pipe (8) passes through an economiser (9) and feeds the drum (10) of the low-pressure steam generator (11). The steam developed in the latter is admitted, after having passed through a low-pressure superheater (12), to the low pressure stage of the main turbine (5). A part of the water in the drum (10) is taken by a high-pressure feedpump (13), and introduced into the drum (14) of the high-pressure steam generator (15) through the intermediary of a high-pressure economiser (16). The saturated steam from the high-pressure steam generator (15) is led by a duct (17) to the steam turbine (4) coupled to the blower (3), and, after expansion in this turbine, the steam is led by a duct (18) to a high-pressure superheater (19), and then to the high-pressure stage of the main turbine (5). Thus, it will be seen that the driving turbine (4) of the boiler (3) is placed in series with the main turbine as regards steam flow. It may be shown that with such an arrangement, the steam turbine (4), having been designed for normal working load continues to produce at different loads on the main turbine (5), a power equal to the blowing power necessary to cool the reactor. The arrangement described, therefore, ensures automatic regulation of the blowing power as a function of the load without the necessity of using regulating apparatus. This automatic regulation is especially important from the point of view of safety, since suitable cooling of the reactor is ensured under all circumstances, notably in the case of insertion of the shut-off rods of the reactor or of over-power. This arrangement produces, in addition, a notable increase in the thermodynamic efficiency of the installation. In the case of an existing installation, calculations effected on hypotheses far from being the most favourable, have shown that the efficiency increases by a figure of at least 3 per cent. *British Patent No.* 806,589 *issued to Babcock & Wilcox Ltd. Complete specification published December* 31*st*, 1958.

It is with regret that we record the death on January 8th, after a protracted illness, of **Mr. Henry Oswald,** M.I.E.E., managing director of British Brown-Boveri Ltd. Mr. Oswald was born in Switzerland in 1902, and received his training with Brown, Boveri. He was appointed contract engineer with British Brown-Boveri, London, in 1928, and in 1932 was appointed representative and resident engineer in India for the Swiss Brown, Boveri. He became general manager of British Brown-Boveri in 1937, director and general manager in 1941, and subsequently managing director.

* * *

The English Electric Co. Ltd. announces that in view of the continuing expansion of the company at home and overseas, and of the wider responsibilities now carried by members of the central management, the appointments of the following executives have been redesignated as follows:—**Mr. E. B. Banks,** A.M.I.E.E., is appointed director of commercial policy, contracts and sales; **Mr. P. L. de Laszlo,** O.B.E., is appointed director of corporate affairs; **Mr. W. M. Hurton** is appointed director of group manufacturing development; **Mr. L. H. Short,** M.C., M.I.E.E., M.Inst.T., is appointed director of overseas operations.

* * *

Mr. Allen L. Stock, managing director, the Morgan Crucible Co. Ltd., has been elected chairman of the London Chamber of Commerce, in succession to **Sir Harold Gillett.**

* * *

The London district office address of **Metropolitan-Vickers Electrical Co. Ltd.,** formerly at 1-3, St. Paul's Churchyard, has been changed to 33, Grosvenor Place, London, S.W.1. Telephone: Belgravia 7011.

* * *

The directors of G. & J. Weir Limited announce with regret the resignation of **Mr. Ian G. Craig,** head of the Contracts Division, and a member of the Cathcart Executive Board.

Mr. Arnold Carr, deputy chairman of Thos. W. Ward Ltd., Albion Works, Sheffield, has been appointed chairman of three Ward subsidiaries:—Thomas Smith & Sons (Rodley) Ltd., Rodley, nr. Leeds, excavator and mobile crane manufacturers; John Smith (Keighley) Ltd., Keighley, Yorks, makers of overhead travelling cranes; and Widnes Foundry & Engineering Co. Ltd., Widnes, Lancs, makers of iron castings, fabrications, etc. This appointment is consequent upon the death of **Mr. Frank R. Stagg,** M.I.Struct.E., who was for many years chairman of these three companies.

* * *

Dr. J. A. L. Bonnell, M.B., B.S., M.R.C.S., L.R.C.P., senior medical officer to the Central Electricity Generating Board, has been appointed nuclear medical officer and deputy to **Mr. C. A. Adams,** chief nuclear health and safety officer of the Board.

* * *

It is with regret that we record the death recently of **Mr. B. E. G. Forsling,** M.I.Mech.E., M.I.Mar.E., who for the last eight years had been manager of the BTH gas turbine engineering department at Rugby.

* * *

The South-Eastern area office of **Birlec Limited,** manufacturers of heat treatment furnaces, dryers and gas plants, has been transferred to Crown House, Aldwych, London, W.C.2 (telephone number: Temple Bar 8040). The South Eastern area office of Birlec-Efco (Melting) Ltd. has also been established at the same address.

* * *

For many years **Cambridge Instrument Co. Ltd.** have had the problem of displaying modern industrial and scientific apparatus in a Georgian setting. Their showroom at 13, Grosvenor Place, London, S.W.1, has now been completely redesigned and redecorated in modern style and the instruments shown are the company's latest models, mounted on well-designed, easily accessible fixtures and showcases.

The Spediflam II burner watcher manufactured by **Teddington Industrial Equipment Limited** for the control and protection of pressure-jet oil-burners, has just been accepted by the Council of Industrial Design for "Design Index," the illustrated record of well-designed British goods from which exhibits to be displayed in the Design Centre are chosen. The particular model which has been accepted was exhibited for the first time at the Fuel Efficiency Exhibition in October last, and uses a new photo-resistive detector which is smaller and considerably more sensitive than the normal photo-emissive type.

* * *

Mr. R. Craig Wood, managing director of A.E.I.-Hotpoint Ltd. since 1956, has been elected a director of Associated Electrical Industries Ltd. In this capacity he will continue to have responsibility for the domestic appliance business of A.E.I.

* * *

Mr. A. Douglas Sharp has been appointed a director of Brightside Heating and Engineering Company Limited. Mr. Sharp is the chairman and managing director of Rashleigh Phipps and Company Limited, and chairman of S.L.R. Electric Limited.

* * *

Mr. W. G. Holliday, M.I.P.R., M.I.A.M.A., has been appointed group publicity manager of the Lancashire Dynamo group of companies and will be generally responsible for all aspects of publicity and public relations throughout the group. Mr. Holliday began his career with W. S. Crawford Ltd., served with other advertising agencies and held publicity appointments in various industrial concerns before joining Lancashire Dynamo in 1950. In 1953 he was appointed manager, Lancashire Dynamo Group Publicity Services.

* * *

Associated Electrical Industries announce the appointment of **Mr. S. C. Leslie** as consultant on information policy, both external and internal.

NOTES *Personal* AND *Industrial*

Sir Willis Jackson, Director of Research & Education, Metropolitan-Vickers Electrical Co. Ltd., has accepted an invitation to act as chairman of a committee, set up by the President of India, to review the work of the Indian Institute of Technology, Kharagpur. Sir Willis Jackson also participated in the Indian Science Congress, which was held in New Delhi from January 21st-28th.

* * *

Mr. Stanley F. Steward, C.B.E., is to succeed **Colonel B. H. Leeson,** C.B.E., T.D., as director of the British Electrical and Allied Manufacturers' Association (Inc.) on his retirement later this year. Mr. Steward has been appointed director-designate with effect from February 1st, 1959. Mr. Steward resigned his position as group managing director of Lancashire Dynamo Holdings Ltd., and as chairman of Lancashire Dynamo and Crypto Ltd., Lancashire Dynamo Electronic Products Ltd., and Lancashire Dynamo Group Sales Ltd., on January 31st, 1959.

* * *

Sir George Nelson, Bt., M.I.Mech.E., M.I.E.E., **Brigadier-General Sir Harold Hartley,** and **Mr. A. M. Holbein,** M.Inst.C.E., have been appointed vice-presidents of the City and Guilds of London Institute.

* * *

Richardsons Westgarth and Co. Ltd. announces that **Mr. A. A. E. Wise** has been appointed a director. **Mr. J. O. M. Fisher** retired from the board on December 31st, but will continue to be a director of the subsidiary company, the Humber Graving Dock and Engineering Co. Ltd.

* * *

Ferranti Ltd. announce that **Mr. A. J. Gray,** B.Sc., A.M.I.E.E., works manager of the transformer department, has been appointed general works manager of the company, following the retirement of Mr. W. Hunt, M.B.E., J.P. **Mr. G. R. C. McDowell,** B.Sc., succeeds Mr. Gray as works manager of Transformer Department.

* * *

The English Electric Co. Ltd. announces that **Mr. H. G. Nelson,** M.Inst.C.E., M.I.Mech.E., M.I.E.E., managing director of the company, has now been appointed deputy-chairman of the following subsidiary companies of the Group: D. Napier & Son Ltd., Marconi's Wireless Telegraph Co. Ltd., Marconi Instruments Ltd., English Electric Valve Co. Ltd., Vulcan Foundry Ltd., Robert Stephenson & Hawthorns Ltd., and of the associated company, The Marconi International Marine Communication Co. Ltd.

* * *

Mr. K. R. Hopkirk, director and, since 1949, chief mechanical engineer of British Thomson-Houston, has retired after forty-three years with the company.

Mr. Harold Sinclair, M.I.Mech.E., who has been managing director of Fluidrive Engineering Co. Ltd. for 30 years, has retired. He will continue as chairman of the board and will be engineering director. **Mr. Leonard Watson,** F.C.I.S., an executive director, who has been with the company since 1934, becomes managing director.

* * *

Mr. S. A. Couling, M.I.Mech.E., A.M.Inst.C.E., of the chief engineer's department, British Thomson-Houston Rugby, and formerly chief gear engineer, has retired after 33 years' service with the company.

* * *

Consequent upon his recent appointment as chairman of A.E.I. Divisional Management Co. Ltd., and divisional director and general manager of the A.E.I. Heavy Plant Division, **Mr. L. Drucquer** has relinquished his appointment as a member of the BTH board.

* * *

Lancashire Dynamo Holdings Limited announce the appointment of **Mr. D. C. Lorkin,** F.C.I.S. (previously joint managing director with Mr. S. F. Steward, C.B.E.), as the managing director of the company. This appointment is consequent upon Mr. Steward's resignation of the position of joint managing director of the company and his appointment as director-designate of B.E.A.M.A. Mr. Lorkin joined Lancashire Dynamo & Crypto Ltd. in 1932, becoming a director in 1946 and managing director of L.D.C. in 1951, a position he still retains. It will be recalled that Lt.-Col. G. S. Marston, D.S.O., M.C., became chairman of the company in August last year.

* * *

Woodall-Duckham Construction Co. Ltd. announces that **Mr. James Simpson** has been appointed deputy chairman, and **Mr. E. N. Wenborn,** joint managing director.

* * *

The United Kingdom Atomic Energy Authority have appointed **Mr. L. Grainger,** B.Sc., A.M.Inst.Met. as head of the Metallurgy Division in the Authority's Research Group at Harwell. He is to succeed **Dr. H. M. Finniston,** B.Sc., Ph.D., A.R.I.C., who is being released by agreement to take up appointment with the Nuclear Power Plant Company.

* * *

The South of Scotland Electricity Board announces that **Mr. William Hutton** has been re-appointed as deputy chairman from January 1st, 1959, to December 31st, 1963, and **Mr. Ian Macdonald,** as part-time member of the board from January 1st, 1959, to December 31st, 1961. **Mr. James Ballantyne** and **Mr. Alexander Sutherland** have been appointed part-time members of the board from January 1st, 1959, to December 31st, 1961.

Simon-Carves Ltd. has announced the following appointments to the board of its subsidiary company, Lodge-Cottrell Ltd.: **Mr. J. P. V. Woollam,** M.I.Chem.E., chairman; and **Mr. R. B. Potter,** M.I.Mech.E., **Mr. N. Hinton** and **Mr. P. D. Taylor,** directors. **Mr. D. H. Richards,** managing director, and **Mr. H. G. Trevor Busby** and **Mr. E. R. Watkins,** executive directors, will retain their previous appointments.

* * *

After nearly forty-four years' service with the British Thomson-Houston Company, **Mr. Herbert Dreghorn,** B.Sc., F.I.W.M., manager (Manufacturing), Rugby works and sub-factories, has retired. Mr. Dreghorn was appointed general superintendent of Rugby works and sub-factories in 1949 and was appointed to the position from which he has now retired in 1957.

* * *

Mr. F. C. Perry, chief mechanical designer (rotating machines), Crompton Parkinson (Chelmsford) Ltd., retired recently, after 47 years of almost continuous service with the company. **Mr. J. W. Kelham,** thd new chief mechanical designer (rotating machines), has been with Crompton Parkinson (Chelmsford) Ltd. since 1954, when he took charge of the development drawing office in London.

* * *

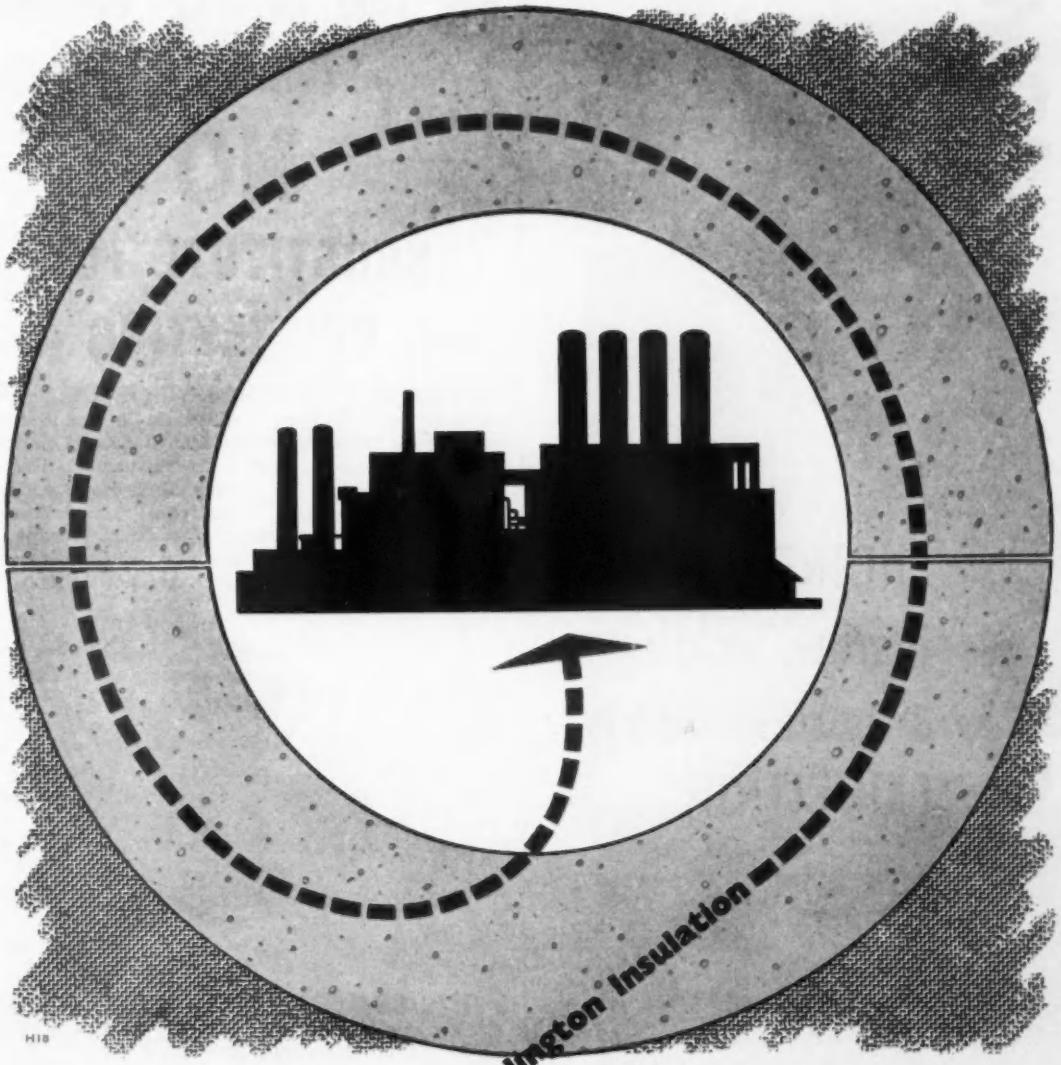
Hayward Tyler and Co. Ltd. and Sumo Pumps Ltd. have announced the establishment of a joint office at Devereux House, Church Hill, Coleshill, near Birmingham (telephone Coleshill 2233/4), to serve their respective interests in the Midlands.

* * *

As already announced, the Power Plant Division of **Elliott Bros. (London) Ltd.** moved early in 1958 to the offices of **James Gordon & Co. Ltd.,** Dalston Gardens, Stanmore. This division has now been amalgamated with James Gordon & Co. Ltd., so that Gordon can in future offer schemes for complete instrumentation and control (either pneumatic or electronic) for nuclear and thermal power stations, process steam plants, heating, ventilating and air-conditioning plants, etc. **Mr. R. Hussey,** who for several years was manager of the Power Plant Division, has taken up the position of sales director of James Gordon & Co. Ltd.

* * *

From time to time courses for senior technical executives in industry are held at the Harwell Reactor School. The next of these courses on which places are available will be held from June 15th-25th, 1959. The fee for the course is fifty guineas exclusive of accommodation and those who are interested should apply for application forms and details to: **The Principal, Reactor School, Atomic Energy Research Establishment,** Harwell, Didcot, Berks.



High Thermal efficiency means Darlington Insulation

Year after year the Central Electricity Generating Board's list of power stations with the highest operating efficiencies includes a majority of stations where the efficiency is guarded by Darlington Insulation. In the 1957 list, for example, the top four stations are Darlington insulated.
Coincidence ? Not a bit of it ! Just skill and years of experience, plus careful specifications and the right materials.
It's The Darlington Insulation Company's job to help maintain high thermal efficiencies, and they do it very well.

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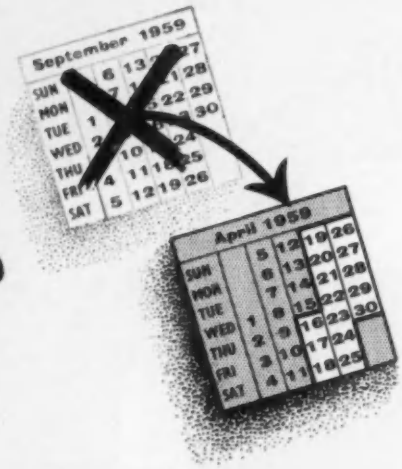

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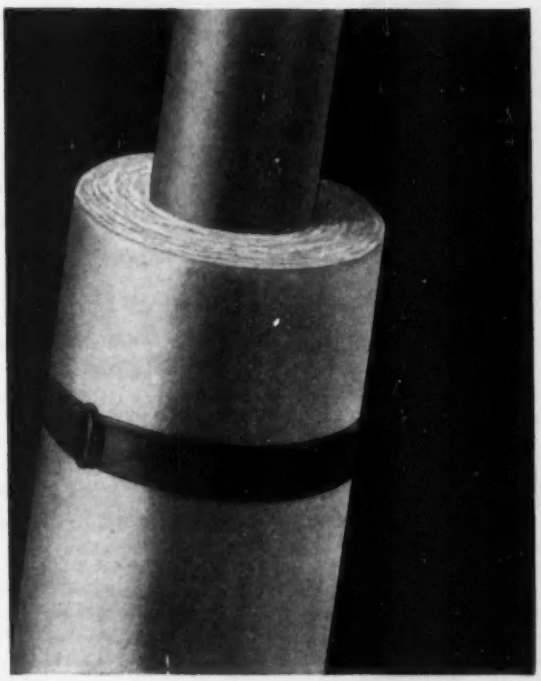

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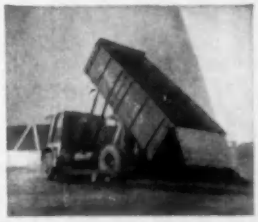

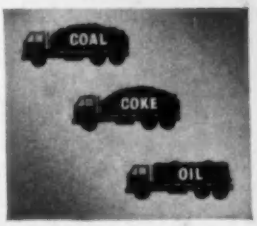

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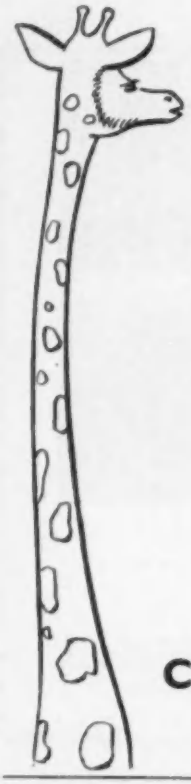

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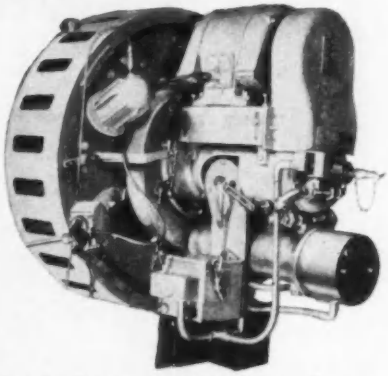

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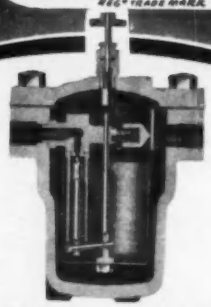

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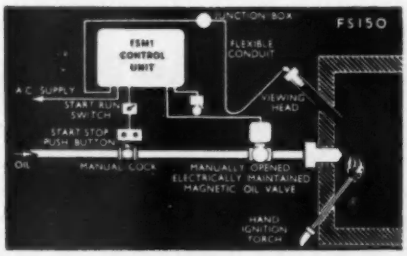

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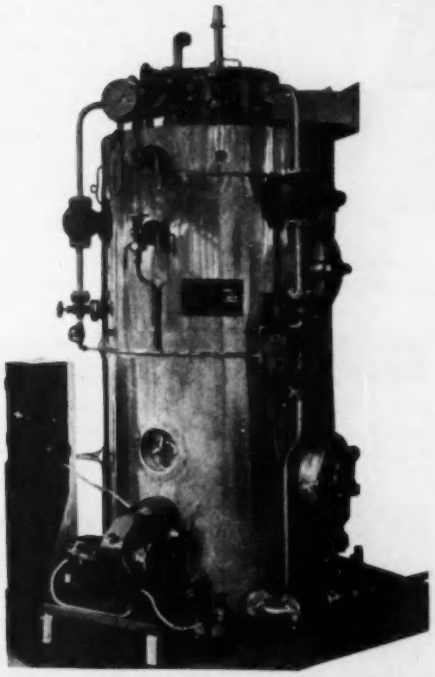

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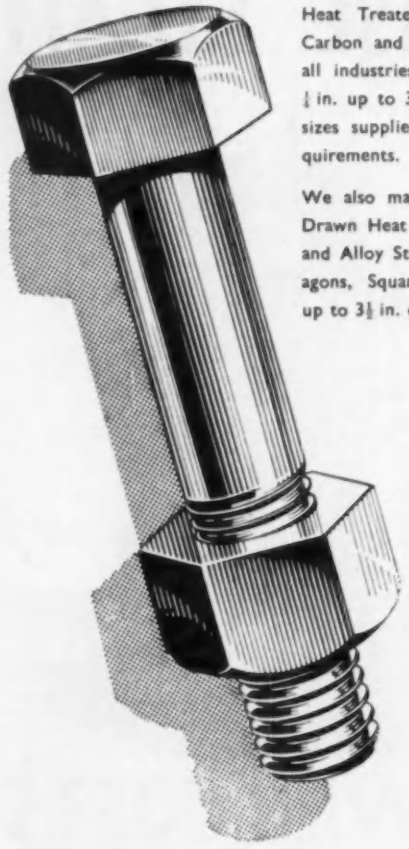

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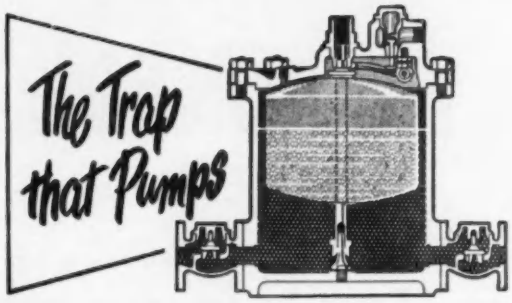

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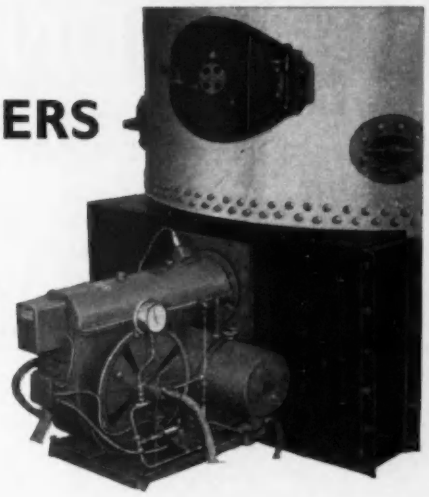

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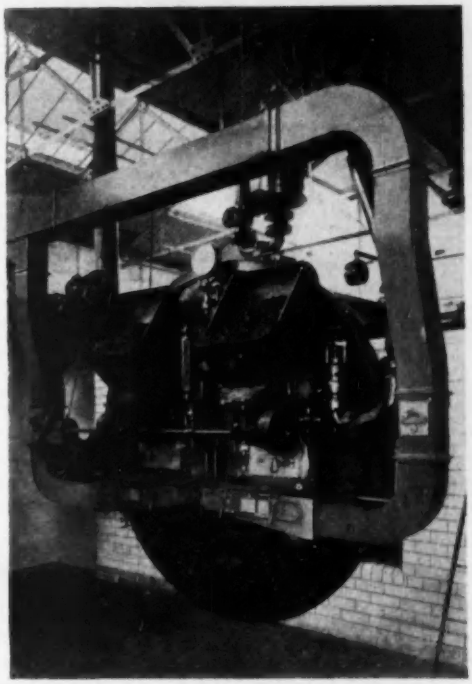

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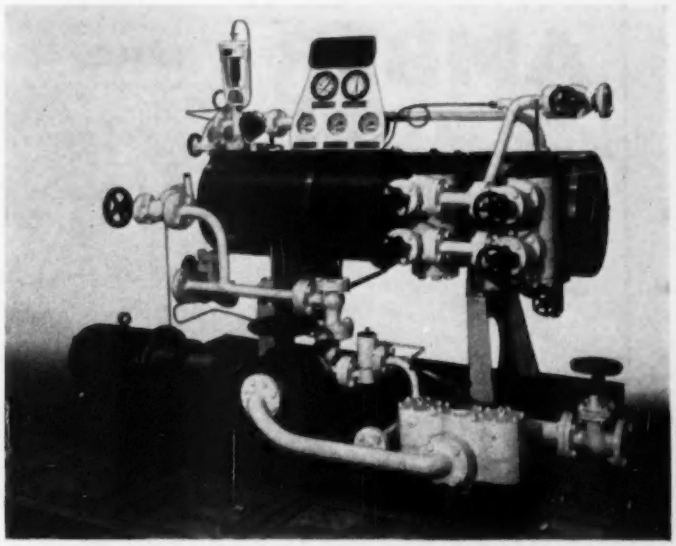

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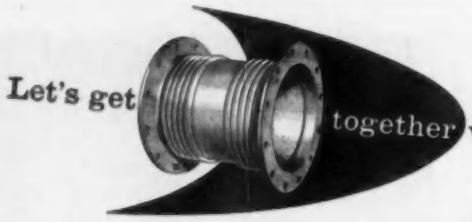

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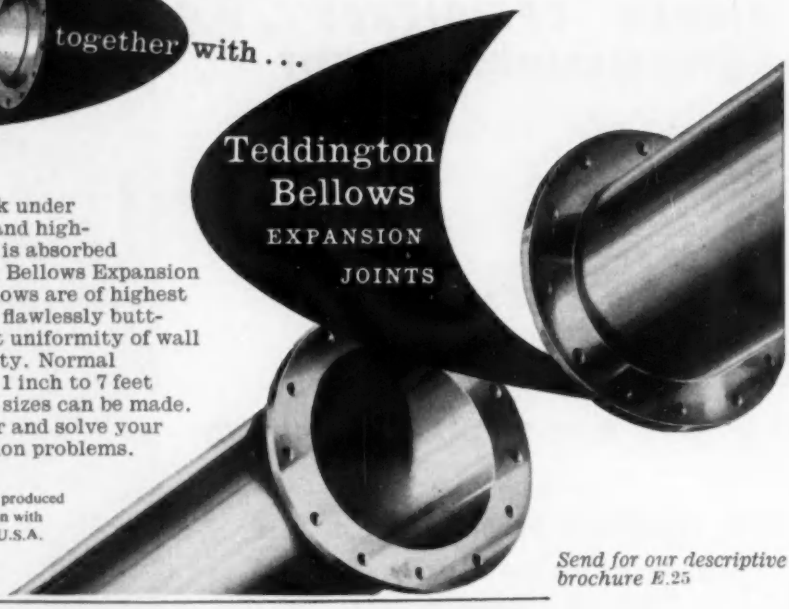

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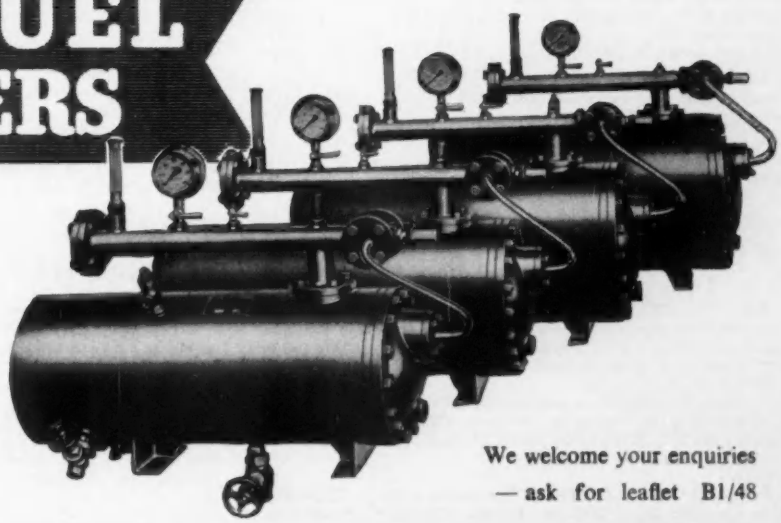

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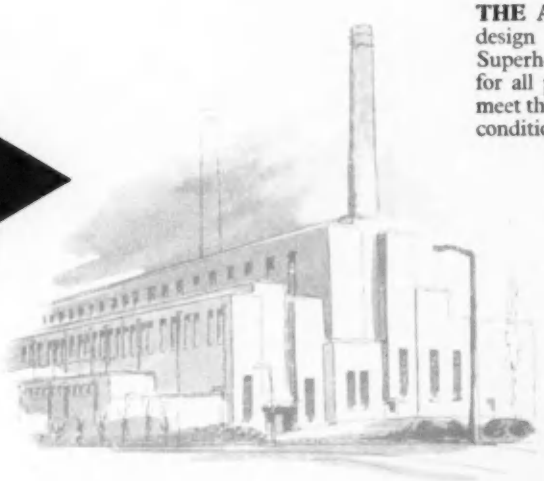

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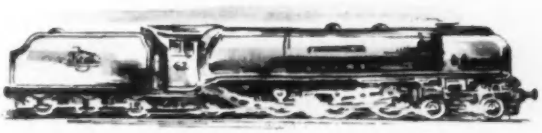

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Printed by Electrical Press Ltd., at Cordwallis Works, Maidenhead, Berks.
Registered for transmission by Magazine Post to Canada including Newfoundland.